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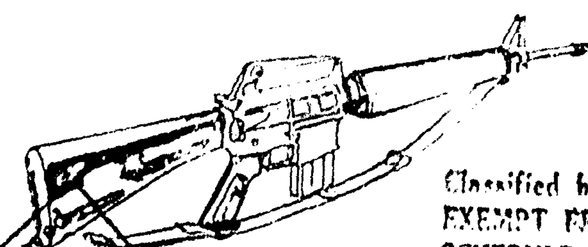
APPENDIX 6

REPORT OF THE M16 RIFLE REVIEW PANEL



1 JUNE 1968

REVIEW AND ANALYSIS OF M16 SYSTEM RELIABILITY

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF
FOR RESEARCH, DEVELOPMENT, AND ACQUISITION
WASHINGTON, DC 20310

REPLY TO ATTENTION OF

DAMA-WSW

1 FEB 1994

MEMORANDUM FOR THE RECORD

SUBJECT: Declassification Action - Report of the M16 Rifle Review Panel (C) dated 1 June 1968. [redacted]

1. The Report on the M16 Rifle Review Panel dated 1 June 1966 was prepared for the Office of the Chief of Staff of the Army, by the Office of the Director of Weapons System Analysis. The Ground Combat Systems Division, Office of the Director of Weapons Systems, Office of the Deputy Chief of Staff for Research, Development and Acquisition, is the successor to the originator of the report.

2. This office has completed a review of subject report and appendices 1 through 11 and has determined classification of Confidential is no longer needed. The report is now Unclassified. Selected extracts of the report are at Enclosure 1.

3. Notification of this declassification will be forwarded to all distribution addressees and a declassified copy will be forwarded to the Defense Technical Information Center, Cameron Station, for file.

1 Encl
as

WILLIAM O. COOMER
Colonel, GS
Chief, Ground Combat Systems
Division

file

[redacted]

Appendix 6

REVIEW AND ANALYSIS OF M16 SYSTEM RELIABILITY

1 June 1968

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Appendix 6

Review and Analysis of M16 System Reliability

Table of Contents

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Figures

Tables

Appendix 6

REVIEW AND ANALYSIS OF M16 SYSTEM RELIABILITY

A. Introduction

The reliability of any Army weapon system depends on the reliability of each component of that system. In the case of small arms these are the man, the weapon and accessories, and the ammunition. This analysis will examine the reliability of the M16 weapon and ammunition combination under stated conditions of maintenance and maintenance schedules. The percentage of system failures, or malfunctions, experienced in Vietnam in the fall of 1966 and the spring of 1967 that could be attributed to the man component, that is, to the rifleman and his supervisors, cannot be determined; however, man failures are discussed in connection with M16 rifle training (Appendix 3) and in the Vietnam surveys on the M16 rifle (Appendix 7).

Certain terms used in this analysis have specific meanings in connection with the weapon system: the reliability of a weapon is the extent to which it will operate for extended firings without a malfunction;[1] a stoppage is any unintentional interruption of the cycle of operation of the weapon;[2] immediate action is the unhesitating application of a probable remedy to reduce a stoppage without investigating the cause;[3] and a malfunction is the failure of

[1] The reliability of a weapon is normally expressed in the number of malfunctions experienced per 1000 rounds fired.

[2] FM 23-9, Jul 66, para. 14.

[3] FM 23-9, Jul 66, para. 15.

the weapon to operate in the normal (or designed) manner, whether or not a stoppage occurs.

There are three types of malfunctions. A Type I malfunction is one that causes a stoppage in firing regardless of how easily the stoppage may be cleared. Failures to feed, to fire, to extract, and to eject are the most common. A broken or damaged part is included in the definition of a Type I malfunction if the part is a critical component in gun functioning, even if the breakage did not cause a stoppage.

A Type II malfunction is one that does not cause a stoppage but does reduce significantly the effectiveness of the weapon, preventing it from completing its full mission. Firing two rounds on a single trigger pull, with the selector set for semiautomatic fire is one example of a Type II malfunction; a rear or front sight that will not remain as set, that is, one that changes settings when the weapon is fired, is another.

A Type III malfunction is one that does not cause a stoppage or otherwise significantly reduce the effectiveness of the weapon. A failure of the bolt to remain to the rear after the last round in a magazine is fired is an example of this kind of malfunction. (For the identification, abbreviation, and description of the most common malfunctions of the M16A1 rifle, see Inclosure 6-1.)

While reliability is critical to all weapons systems it is one of the most important characteristics of the rifle, which is the arm of the infantryman. According to one of the Small Arms Weapons Systems (SAWS) Study documents:

> Durability and reliability are those features of design and construction which will enable a weapons system to function in sustained infantry combat under varying conditions of climate, terrain and combat environment. Excessive maintenance requirements (to insure functional reliability), and necessity for special precautionary operating techniques, to preclude damaging weapons, are not acceptable. Both the weapon and ammunition must function effectively for a reasonable period of time, or for an acceptable number of rounds fired without a high malfunction rate.4/ The firer should be able to clear malfunctions or stoppages that occur by the application of immediate action. Finally, the functional reliability will enhance the firer's confidence in the weapon with a resulting increase in weapon effectiveness.5/

> Due to a lack of confidence of personnel in an unreliable weapons system, they may become reluctant to engage the enemy. . . . this characteristic becomes more critical as ranges become closer and the firer's vulnerability becomes greater.6/

Since there have been many changes in both the M16 rifle and its ammunition since the first tests were conducted, and since test conditions and controls have varied from test to test, an analysis of the system reliability will be made of each set of data presented.

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4 "A reasonable period of time"; "an acceptable number of rounds," and "a high malfunction rate" are not defined for any small arms system. Theoretically, of course, a weapon should function <u>all</u> the time on <u>every</u> round <u>without</u> any malfunctions.

5 USACDCIA Staff Study, Weapons Characteristics Affecting Infantry Tactics and Techniques, Jun 65, Annex B, para. 3a(4).

6 Ibid., Annex C, para. 3c.

B. History of M16 Rifle Systems Reliability

Prior to 1962

Before 1962 there were five test reports which provided usable reliability data. The results are analyzed here in chronological order.

A USAIB Test

The first was the U.S. Army Infantry Board (USAIB) Evaluation Report on the Armalite AR15, 27 May 1958. The purpose of the test was "To determine the potential of the Armalite (AR15) small caliber high velocity rifle to replace the M14 and M15 rifles." The report covered only tests made under temperate climate conditions; Arctic tests were conducted and reported separately. The conclusions indicated that the AR15 was superior to the M14 with respect to weight, ease of assembly and disassembly, reliability under simulated combat conditions, and ease of handling. The AR15 was found inferior to the M14 only in penetration and flash suppression. In all other respects the two weapons were comparable.

The original AR15 rifle configuration was submitted to the Army for evaluation. The weapon had a light barrel, no flash hider, no bolt assist device, no chrome chamber, and was equipped with the original buffer design. It was a scaled down version of the AR10 (7.62mm). The AR15 had been in the process of development less than a year (development had begun about June 1957) and rifles tested were not production models. During the course of the test, the gas port in the AR15 barrel was enlarged an additional .005 inch, from .077 to .082 inch, to provide more gas power for operating the rifle. This change had been found necessary when the operating parts and chamber became dirty during the simulated combat conditions test. The original 25-round magazine was used in the test. Production models of the M14 (T44E4) were used as control weapons.

Two types of ammunition for the AR15 were used in testing: ball cartridge caliber .224, Winchester E2, with a 53-grain projectile at a muzzle velocity of 3,300 feet per second, which was used for all tests, and ball cartridge .222 Remington, with a 55-grain projectile at a muzzle velocity of 3,275 feet per second. which was used only in the penetration test for comparison purposes. The Remington cartridge was developed to the specifications of Armalite. Although the type of propellant used in these cartridges was not mentioned in the report, Remington loaded only IMR 4475 propellant in the early ammunition lots. Ball cartridge 7.62mm, M59, Lot LC 12011 was used as control ammunition; the M59 was the standard round for the M14 at that time.

The reliability of the weapons was assessed under simulated combat conditions as follows:

Test 7. Simulated Combat Conditions

1. Purpose. To determine and compare the performance of the test and control rifles under simulated combat conditions.

2. Method.

a. A course consisting of six lanes was constructed. Obstacles of various types (barbed wire fences, ditches, shell holes, etc.) were constructed in each lane so that the lanes become progressively more difficult, lane 1 being the least difficult and lane 6 being the most difficult. No minimum acceptability criterion was established since the purpose of the course was to establish relative performance. Each weapon entered the course at lane 1 and proceeded through the firing points (five firing points in each lane) until 8 out of 10 rounds resulted in malfunctions (four malfunctions of 5 rounds fired at each of two successive firing points). The weapon was then removed from the course, field stripped and cleaned. In the event of breakage or stoppages that could not be corrected by the soldier negotiating the course, the weapon was removed from the course, cause of breakage or stoppage determined, and the weapon disassembled and cleaned prior to restarting in lane 1. Each weapon entered the course at lane 1 four times (three semi-automatic fire runs and one automatic fire run).

b. Malfunctions by type and number of firing points completed were determined and recorded for each type rifle.[7]

The results of Test 7 are as follows:[8]

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7 Rpt of Project 2787, Evaluation of Small Caliber High Velocity Rifles-Armalite (AR15), USAIB, 27May 58, Test 7, p. 11.

8 For detailed malfunction data, see Inclosure 6-2, Table 1.

Weapon	Mode of Fire	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds[a]	Points Completed
AR15	Semiautomatic	2,916	179	61.4	41
M14	Semiautomatic	1,586	253	159.5	23
AR15	Automatic	662	81	122.4	28
M14	Automatic	751	101	133.2	32
Total AR15		3,578	260	72.7	69
M14		2,337	354	151.5	55

a Average for all runs.

The reliability of the weapons was assessed under adverse conditions as follows:

Test 8. Adverse Conditions

1. Purpose. To determine and compare the performance of the test and control weapons under adverse conditions.

2. Method.

a. Clean and properly lubricated test and control rifles (two of each type) were fired, at the rate indicated below for 5 days without further care and cleaning.

1st day	40 rounds per minute for 5 minutes.
2d day	15 rounds per minute for 30 minutes.
3d-5th day	8 rounds per minute for 15 minutes.

b. Prior to each exposure to the conditions discussed below, the test and control rifles (two of each type) were thoroughly cleaned, properly lubricated and fully loaded, including one round in the chamber. Spare magazines (loaded) in ammunition pouches were exposed to the same adverse conditions.

(1) The rifles were submerged in muddy water for 5 minutes then drained and fired. The rifles were then cleaned and again submerged in muddy water for 5 minutes, drained, left to dry for 24 hours and fired. (Muddy water approximated that found in shell holes, etc., on the battlefield.)

(2) The rifles were fired while exposed to an artificially generated 25-mph wind laden with dust and sand. This exercise was repeated to allow rotation of weapons and change in wind direction (left-right sides).

(3) The rifles were fired in a light downpour of artificial rain (100 rounds).

c. Clean and properly lubricated test and control rifles (two of each type) were stored, with loaded magazines and a round in the chamber, in a cold room at -25°F for 72 hours, then transported in insulated containers to the testing range and fired (100 rounds).

d. Clean and properly lubricated test and control rifles (two of each type) were stored with loaded magazines and a round in the chamber, in a hot room at 125°F for 72 hours, then transported in insulated containers to the testing range and fired (100 rounds).

e. Clean and properly lubricated rifles (two of each type) were fired (100 rounds), stored with loaded magazine and a round in the chamber, in a cold room at -25°F for 24 hours, then transported in insulated containers to the testing range and fired (50 rounds).[9]

The results of the adverse condition tests were:

Test	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
5 days without care and cleaning	AR15	2,020	10	5.0
	M14	2,020	0	0.0
Muddy water	AR15	40	34	850.0
	M14	41	36	878.0
Sand and dust	AR15	81	19	234.5
	M14	33	32	969.7
Artificial rain	AR15	200	0	0.0
	M14	200	3	15.0
-25° for 72 hours	AR15	200	2	10.0
	M14	200	0	0.0
125° for 72 hours	AR15	200	1	5.0
	M14	200	48	240.0
100 rounds then -25° for 24 hours	AR15	100	0	0.0
	M14	100	0	0.0
Total — All adverse conditions	AR15	2,841	66	23.2
	M14	2,794	119	42.6

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9 Rpt of Project 2787, Evaluation of Small Caliber High Velocity Rifles, Armalite (AR15) USAIB, 27 May 58, Test 8, p. 14.

The evaluation was a valid comparison of a limited sample of weapons (2 AR15s and 2 M14's) and ammunition reliability under extremely adverse conditions. Although the report suggested some product improvements in the weapon,[10] it concluded that the AR15 was more reliable than the M14 in a temperate climate.

AN ARCTIC TEST

The second report in this period that yielded usable information was the U.S. Army Arctic Test Board Evaluation Report on the Armalite (AR15), 17 April 1959. The purpose of the test was "To determine the potential of the small caliber high velocity rifles to replace the M14 and M15 rifles under arctic winter conditions." The conclusions indicated that "The AR15 rifle, when modified to correct deficiencies, . . . is a potential replacement for the M14-M15 rifle for Army use under arctic winter conditions." Further, the report noted that "attempts were made to fire two each AR15, M14, BAR, and M1 rifles at ambient temperatures ranging from -53° to -56°F. The two AR15 rifles were the only rifles that functioned."

The weapon tested was the same as that described for the USAIB evaluation test above, the AR15 serial numbers 7, 8, and 9. The control weapon, M14, was also the same. Ball cartridge, caliber .224 Winchester E2, Lot 24NC91 (1958) loaded with IMR propellant was used. The M59 7.62mm ball cartridge, Lot FAX7.62L2369 (1954)

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[10] See Appendix 11 for details of product improvements recommended or accepted.

was used as control ammunition.

The reliability of the weapons was assessed under adverse conditions as follows:

Test 7. Adverse Conditions

1. Purpose. To determine and compare the performance of the test and control rifles under adverse conditions.

2. Method.

a. Phase 1: After cold-soaking in the open at ambient temperatures ranging from 8°F to -21°F for 58 hours, two each AR15 and M14 rifles were moved into a warm shelter for 30 minutes where ambient temperatures ranged from 75°F to 70°F. They were then returned to the open, exposed to an ambient temperature of -4°F for one hour, and each fired 100 rounds. Rifles were then field cleaned and lubricated, fired 100 rounds each, allowed to cool for 2 hours, and again fired 100 rounds each. Ambient temperatures ranged from -1°F to -4°F.

b. Phase 2: After cold-soaking for 17 hours at ambient temperatures ranging from -2°F to -6°F two each AR15 and M14 rifles, fired 60 rounds, were buried in snow for 30 minutes and again fired 60 rounds. The burying and firing cycle was repeated 6 times during which the rifles were buried 3 times with the sights up and 3 times with the sights down at an ambient temperature of -4°F.

c. Phase 3: After cold-soaking for 15 hours at ambient temperatures ranging from -4°F to 24°F, two each AR15 and M14 rifles were moved into a warm shelter for 20 minutes at an ambient temperature of 75°F, returned to the open and allowed to cool for one hour at an ambient temperature of -8°F, fired 60 rounds and again allowed to cool for one hour. The complete cooling and firing cycle was repeated 3 times while ambient temperatures ranged from -5°F to -8°F.

d. Phase 4: Two each AR15 and M14 rifles were function fired, cleaned, lubricated, and then exposed to blowing snow and glacial dust for 37 hours at ambient temperatures ranging from 19°F to -5°F. Forty rounds were fired from each rifle to determine proper functioning (twenty rounds fired semiautomatic, 20 rounds fired automatic).

e. Malfunctions, breakages, and any unusual performance were ascertained and analyzed.[11]

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[11] Rpt of Project 2787 (Arctic), Evaluation of Small Caliber High Velocity Rifles, U.S. Army Arctic Test Board, 17 Apr 59, Incl 1, pp. 12-13.

The results of the adverse conditions tests were:

Phase	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
Phase 1	AR15	300	8	26.7
	M14	300	0[a]	0.0
Phase 2	AR15	420	5	11.9
	M14	420	2[a]	4.8
Phase 3	AR15	180	3	16.7
	M14	180	1[a]	5.6
Phase 4	AR15	40	48[b]	1200.0[b]
	M14	40	17[a]	425.0
Total	AR15	940	64	68.1
	M14	940	20	21.3

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[a] The report indicated that the gas cylinder plug of the M14 continually loosened during all firings, which would ultimately result in a failure to feed (FF) stoppage because of insufficient gas. The number of times the gas plugs had to be tightened was not reported, therefore the M14 malfunction rate indicated is not valid.

[b] The AR15 was charged with 48 malfunctions while firing only 40 rounds of ammunition. Five "failures of the bolt to remain to the rear when the last round was fired" were charged to the AR15, indicating that more than one magazine was used in the semiautomatic firing of 20 rounds.

The reliability of the weapons for the entire test was as follows:

Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
AR15	19,706	337[a]	17.1
M14	10,540	31[b]	2.9

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[a] Does not include the number of times the hammer retaining pin became loose and had to be reinserted.

[b] Does not include the number of times the gas cylinder plug became loose and had to be tightened.

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Various characteristics of two each AR15's and M14's were tested under Arctic winter conditions and the results were compared. The reliability data is not completely valid because, as indicated above, the number of times certain malfunctions on both weapons occurred was not recorded.[12] It is significant that the AR15 rifle considerably exceeded the military characteristics (MC) specification of a 5,000-round barrel life (bullets from the two AR15 rifles keyholed at 9,137 and 10,094 rounds), and that the two M14 rifles did not meet the MC specification of a 10,000-round barrel life (bullets from the two M14 rifles keyholed at 4,449 and 4,826 rounds).

A FIRST D&PS TEST

The Development and Proof Services Test of Caliber .22 AR15 rifle; Lightweight Military Caliber .224 Rifle; and Pertinent Ammunition, 3 February 1959; and the D&PS Report on a test of the Caliber .30 Rifle T44E6 27 January 1959, was the third test to provide usable information in this period. This test was in reality a comparative evaluation test between the AR15, the caliber .224 lightweight military rifle, and the T44E6, the M14, utilizing the Standard Light Automatic Rifle Test, the purpose of which was evidently to determine the potential of the AR15 or the lightweight military rifle to replace the M14 and M15 rifles.

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[12] For detailed malfunction data for the entire test, see Inclosure 6-2, Table 2.

The AR15's tested, Numbers 5, 6, 10, 14, and 18, were the same configuration as those used for the USAIB 1958 evaluation. During the rain test it was found that the lightweight barrel would not perform acceptably and a barrel 2 ounces heavier was substituted and did perform acceptably.

In the test, the T44E6 (M14) was used as a control and a test rifle. It is a lightweight M14 with a shorter (20-inch), lighter barrel, a lighter stock, and a lighter receiver and trigger housing. The rifle was not equipped with a selector for automatic fire, a gas shutoff valve, or a bayonet lug. A 20-round lightweight magazine was also provided. All M14 firing during the test was semiautomatic.

The Winchester caliber .224 cartridge, E2, Lot 24NC02, and Remington caliber .222 special cartridge, Lot N270, were used, both with IMR 4475 propellant. The AP cartridge, caliber 7.62mm, M16, Lot LC12027, was used.

The conclusions of the test were as follows:

> The AR15 rifle has the advantages of light weight, light recoil, favorable handling qualities, convenient disassembly and assembly, and good endurance, but a deficient magazine contributes to a high malfunction rate when the magazine is loaded to its capacity. An extremely light barrel, a short sight radius, a large front sight, a lack of convenient sight adjustment, and a heavy trigger pull contribute to poor accuracy characteristics. The rifle is far less effective for obtaining hits on designated targets when fired automatically than when fired

semiautomatically. The original barrel installed on this rifle was too light to be fired safely with water in the bore. However, a modified barrel demonstrated a level of safety comparable with that of standard rifles.

The Lightweight Military rifle has the advantages of light weight, light recoil, favorable handling qualities, and convenient disassembly and assembly, but it has poor accuracy, function and endurance characteristics.

The ammunition has the advantages of light weight and light recoil, but a high level of case casualties indicates a need for further development.[13]

The scope of the USATECOM tests from which reliability data was accumulated is described below.

Test III. Accuracy

a. Four ten-round targets will be fired at a range of 100 yards from a machine rest or from a bench rest by an expert rifleman.

b. A test will be conducted to investigate the accuracy that can be obtained when the rifle is fired under various conditions similar to those encountered in combat. Three riflemen will each fire the following course at 100 yards with the test rifle:

(1) With sights properly adjusted and with a fouled bore, one 10-round target will be fired from a bench rest.

(2) The rifle will be disassembled (field stripped), cleaned, oiled, and reassembled.

(3) Starting with a cold and oiled bore, one 10-round target will be fired from a bench rest.

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13 USATECOM (D&PS) Test of Rifle, Caliber .22, AR15; Rifle, Lightweight Military, Caliber .224; and Pertinent Ammunition, 3 Feb 59.

(4) One 10-round target will be fired from the prone position using a sling.

(5) One hundred rounds will be fired as rapidly as possible.

(6) Immediately after firing the 100 rounds, one 10-round target will be fired from a bench rest.

(7) Another 10-round target will be fired immediately from the prone position using a sling.

c. Three riflemen will each fire ten three-round bursts at a range of 25 yards from the standing position. The course will be repeated from the prone position. A suitable control rifle may be used.

d. Three individuals will fire as many aimed shots as possible in a one-minute period with each semiautomatic and automatic fire. The course will be fired three times per individual and the hits recorded on the E target at 100 yards.

e. Six individuals will fire a standard qualification course with the rifle.

Test IV. Endurance

The rifle will be fired 6000 rounds for endurance, firing alternately 100 rounds semiautomatically and 100 rounds automatically. The rifle will be cooled after each 100 rounds. The entire mechanism may be disassembled, cleaned and oiled after each 600 rounds. All malfunctions, breakages and replacement of parts will be recorded. The instrumental velocity will be measured on 20 rounds, before and after the endurance test. Accuracy will be checked before and after the test. In the endurance test 100 rounds will be fired semiautomatically and 100 rounds will be fired automatically under each of the following conditions:

a. With the rifle held loosely in the hands.

b. With the rifle held right side up.

c. With the rifle held left side up.

d. With the rifle held loosely in the hands at an elevation of 80 degrees.

e. With the rifle held in a normal manner at an elevation of 80 degrees.

f. With the rifle held loosely in the hands at a depression of 80 degrees.

g. With the rifle held in a normal manner at a depression of 80 degrees.

Test VI. Unlubricated.

The rifle will be cleaned in solvent and left in an unlubricated condition. One hundred rounds will then be fired alternating between semiautomatic and automatic fire.

Test VII. Extreme Cold.

The rifle will be cleaned, lightly oiled, and placed with a loaded magazine in a cold room maintained at -65°F, for a 12-hour period prior to firing. After this period an attempt will be made to fire 20 rounds (or the capacity of the magazine) semiautomatically. If satisfactory functioning is obtained, a similar number of rounds will be fired automatically after an additional two hours.

Test VIII. Dust.

The rifle will be cleaned and lightly oiled. It will be fully loaded and the safety will be placed in the 'ON' position. The rifle will then be placed in the dust box and exposed to the dust for one minute top side up and for one minute upside down. The dust mixture, which is made by mixing nine pounds of Grade 0 Albany sand with one pound of clean silica core sand which passed 100 percent through a 30-mesh sieve, 80 percent through a 50-mesh, and 3.4 percent through a 100-mesh, will be poured at a rate of five pounds per minute through the pour hole while the blower is turned at a handle speed of 60 revolutions per minute. The shooter will attempt to clean the rifle by wiping with his bare hands and by blowing sharply on the congested areas of the action. An attempt will be made to fire 20 rounds (or the capacity of the magazine).

Test IX. Mud.

The rifle will be cleaned, lightly oiled, and the muzzle taped to exclude the mud from the bore. The rifle will be immersed completely in the mud for a period of 15 seconds. The mud mixture is made in the proportion of ten pounds of red clay and two pounds of clean river sand with eight quarts of water. The sand is approximately the same grading as that used in the dust test. The shooter will remove the tape from the muzzle and attempt to clean the rifle by wiping with the bare hands and by blowing on the congested areas of the action. An attempt will be made to fire 20 rounds (or the capacity of the magazine).

Test X. Rain.

The rifle will be cleaned, lubricated and subjected to spray which is directed over the entire rifle by means of a 1/2-inch pipe having 0.059-inch holes spaced 1/2 inch apart. The pipe will be positioned three feet above the rifle. The following procedure will be used:

a. The rifle, in a horizontal position, will be exposed to the spray for five minutes with the bolt retracted and for five minutes with the bolt closed. The rifle will be loaded when the bolt is closed. After this time the gun will be fired 100 rounds semiautomatically.

b. The procedure in 'a' will be repeated, except that the gun will be fired automatically.

c. The procedure in 'a' will be repeated, except that the rifle will be exposed to the spray with muzzle up. The rifle will be fired 100 rounds semiautomatically in a horizontal position. Before firing, the muzzle of the rifle will be depressed to permit water accumulating in the bore to run out.

d. The procedure in 'c' will be repeated except that the gun will be fired automatically.

e. The procedure in 'c' will be repeated except that the rifle will be exposed to the spray with muzzle down.

f. The procedure in 'e' will be repeated.

Test XI. Cook Off.

The rifle will be subjected to a test to determine the minimum number of rounds which may be fired before sufficient heating of the chamber occurs to result in a premature explosion of the cartridge. The firing will be conducted as rapidly as possible, employing preloaded magazines. An attempt will be made to bracket the cook off point in number of rounds fired.

The results of these tests were as follows:[14]

Test	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
1. Miscellaneous: accuracy, flash and smoke, cook off, velocity	AR15	3,844	58	15.1
	M14	2,706	2	.7
2. Endurance	AR15	14,090	242	17.2
	M14	11,624	13	1.1
3. Adverse conditions: unlubricated, extreme cold, dust, mud, rain	AR15	2,176	183	84.1
	M14	1,526	65	42.6
4. Total — all tests	AR15	20,110	483	24.0
	M14	15,856	80	5.0

14 For detailed malfunction data, see Inclosure 6-2, Table 3.

The test report stated first that the T44E6 (M14) was less reliable than the standard M14 (T44E4). The difference in malfunction rate was stated as .6 per 1,000 rounds. (T44E4 (M14) was .3 and the T44E6 was .9 per 1,000 rounds.) Secondly, the T44E6 was not fired automatically during the test since no selector levers were supplied with the weapons; automatic fire would have increased the number of malfunctions and hence the malfunction rate. These two factors tend to offset each other, therefore, the test is considered valid enough for comparative purposes.

A USACDCEC TEST

U.S. Army Combat Development Experimentation Center Report on A Rifle Squad Armed with a Lightweight High Velocity Rifle, 30 May 1959, was the fourth test of this period with usable results. The purpose of the experiment was "to compare the relative effectiveness of variously organized rifle squads armed with M14 rifles and the Winchester and Armalite lightweight, high velocity rifles" and "to determine the impact of the lightweight, high velocity rifles on squad organization, techniques, and logistics."15/ The conclusions stated in part that "the Armalite rifle is comparable to the M14 in reliability."16/

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15 Final Rpt, Rifle Squad Armed With a Lightweight High Velocity Rifle, USACDEC, 30 May 1959, Section I, para. 2.

16 Ibid., para. 5d.

Further, the report acknowledged that the experiment was not designed to evaluate weapons reliability, although reliability information was compiled during the daylight attack and defense phases of the experiment and was reported. The ammunition used in the AR15 was Remington, caliber .222, 55-grain projectile, loaded with IMR 4475 propellant. (The lot numbers and time of manufacture were not reported.)

Facts on the reliability of the AR15 and M14 were collected during the period 1 December 1958 - 22 March 1959 by recording malfunctions during 384 runs of the daylight attack phase and 337 runs of the daylight defense phase. No data was reported for the night defense phase of the experiment. The weapons were cleaned at least daily on the days they were fired, and were seldom fired as much as 100 rounds per rifle a day.

The following is a summary of the reliability data collected:[17]

			Malfunctions	
Weapon	Phase of Experiment	Rounds Fired	Total Number	Number per 1,000 Rounds
AR15	Daylight Attack	10,075	34	3.4
M14	Daylight Attack	9,537	32	3.4
AR15	Daylight Defense	12,671	35	2.8
M14	Daylight Defense	12,778	7	.5
AR15	Total	22,746	69	3.0
M14	Total	22,315	39	1.7

17 For detailed malfunction data, see Inclosure 6-2, Table 4.

Both the AR15 and the M14 were subjected to the same firing schedules, the same environment, and the same handling. The manner in which reliability data was reported indicates that the men who collected the data were not sufficiently trained in reporting malfunctions; it is therefore probable that some malfunctions were erroneously diagnosed or escaped detection. Since both weapons were observed by the same data collectors, however, the results are considered valid for comparison.

A SECOND D&PS TEST

The fifth and last test in this period to provide usable data was conducted by the U.S. Army Test and Evaluation Command, Development and Proof Services, and titled A Test of Rifle, Caliber .223, AR15, 21 September - 20 October 1960. The purpose of this test was to compare the performance of the mass-produced AR15 with the experimental model, which was produced in limited quantity and tested by Development and Proof Services in 1958. The test was conducted like the 1958 test, with one minor modification in the rain test - when the muzzle was depressed after being exposed to "rain" for five minutes, muzzle up, the bolt was retracted slightly to help remove water from the bore.

Only the modified production model AR15 was tested. Several design changes which had been made since the previous test significantly contributed to reduction of the malfunction rate. Most notable were:

A new 20-round magazine to eliminate or decidedly reduce magazine-associated (feeding) malfunctions (BOB, FBR, DF, and FF-1)[18]

A redesigned buffer head (Action Spring Guide Assembly). Three longitudinal bearing surfaces were placed on the buffer head instead of the original circumferential bearing surface, thus allowing sand and dust to filter by the buffer head without unduly obstructing its movement. This change was to reduce the number of feeding malfunctions.

Retaining springs on the hammer and trigger pins to reduce the number of times the pins worked loose and caused other malfunctions such as F2R.

There were other changes made in the rifle, which did not affect the malfunction rate; an adjustable rear sight, a bayonet lug, a flash suppressor, a bipod, and a two piece handguard.

Ammunition used in the test was the caliber .223 Remington cartridge, Lot T20L. The propellant was reported as an IMR type, probably IMR 4475.

Results of the tests follows.[19]

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[18] See Inclosure 6-1 for definitions of malfunction abbreviations.

[19] For detailed malfunction data, see Inclosure 6-2, Table 5.

Test	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
1. Accuracy	AR15, 614	944	1	1.0
	AR15, 645	296	0	0.0
	AR15, 682	901	1	1.1
	AR15, 689	199	0	0.0
	AR15, 835	887	0	0.0
2. Endurance	AR15, 614	6,097	14	2.3
	AR15, 682	6,089	25	4.1
	AR15, 835	6,090	7	1.1
3. Adverse conditions: extreme cold, unlubricated, dirt, mud, rain, and cook off	AR15, 614	1,080	14	13.0
	AR15, 682	940	23	24.5
	AR15, 835	920	33	35.9
4. Total - all tests, all rifles	AR15	24,443	118	4.8

When the results of this test are directly compared with the results of the D&PS 1958-59 AR15 test, a dramatic improvement in weapon performance is evident (4.8 malfunctions per 1,000 rounds as compared with 24.0 in 1959). The changes made in the AR15 rifle as well as the new magazine had considerably improved reliability.

EARLY TEST SUMMARY

The AR15 (M16) system reliability prior to 1962 was improving as design changes were made which is normal for a weapon system under development. As a result of deficiencies identified during the tests and evaluations, several changes were made in the weapon-ammunition system that significantly improved the overall reliability of the system as well as improved human engineering and durability. The malfunction rate per 1,000 rounds dropped from a high of 50.8 in the first test to a rate of 4.8 in the last test in 1960. This improvement in reliability and the Air Force interest in the weapon probably prompted further consideration of the AR15 (M16) system by the Army.

Table 6-1--SUMMARY OF AR15 AND M14 TEST RESULTS PRIOR TO 1962

Test	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
USAIB May 1958	AR15	6,419	326	50.8
	M14	5,131	473	92.2
Arctic April 1959	AR15	19,706	337	17.1
	M14	10,540	31	2.9
USATECOM (D&PS) January 1959	AR15	20,110	483	24.0
	M14	15,856	80	5.0
USACDEC May 1959	AR15	22,746	69	3.0
	M14	22,315	39	1.7
USATECOM (D&PS) October 1960	AR15	24,443	118	4.8
Total -- all tests	AR15	93,424	1,333	14.3
	M14	53,842	623	11.6

Further analysis of the tests of this period reveals that failure to feed and other feeding malfunctions were the most frequent. Total malfunctions, by type, in firing 93,424 rounds are indicated below.

Table 6-2 — SUMMARY OF AR15 MALFUNCTIONS BY TYPE PRIOR TO 1962

Type of Malfunctions	Number	Percentage Of Total Malfunctions	Occurrence per 1,000 Rounds
Failure to feed[a/] (FF)	346	25.96	3.70
Failure of bolt to remain rear (FBR)	119	8.93	1.27
Failure to eject (FJ)	97	7.28	1.04
Failure to fire (FFR)	133	9.98	1.42
Failure to extract (FX)	93	6.98	1.00
Bolt overrides base of round (BOB) (a type of FF)	111	8.32	1.19
Double Feed (DF)	7	.53	.07
Broken Part[b/] (BP)	12	.90	.13
Failure of bolt to close[c/] (FBC)	101	7.58	1.08
All other malfunctions	314	23.54	3.36
Total	1333	100.00	14.27

[a] Includes failure to feed first round (FF-1).

[b] Includes defective part (DFP), inoperative part (IP), and damaged part (DP).

[c] Includes failure to strip round from magazine and failure to lock.

The 1962-1963 Comparative Evaluation

During this period five tests and evaluations provided valid reliability data. The following discussion takes up each test and evaluation and assesses the results.

A USACDC TEST

The U.S. Army Combat Developments Command Report on Evaluation of Rifles, 14 December 1962, was the first evaluation in this period to provide usable data on the M14 and M15 rifle systems.[20] The purpose of the evaluation was "To assist the Army Staff in an impartial and objective evaluation of the relative effectiveness of the M14 and the AR15 rifles by conducting the tactical evaluation and troop testing to include (1) comparative troop tests of the M14 and AR15 rifles and (2) an evaluation of the OSD/ARPA (Field Unit, South Vietnam) test of the AR15 rifle." To provide the directed variations in climate and terrain, the troop tests were conducted in the Arctic (U.S. Army, Alaska (USARAL)), 35 miles south of Fairbanks), the desert (Fort Irwin, California), the jungle (U.S. Army, Caribbean (USARCARIB), Panama), and in Europe (U.S. Army, Europe (USAREUR), Baumholder, Germany), at Fort Carson, Colorado, and at Fort Hood, Texas. The report listed the objectives of the troop tests as follows:

> To compare the functioning of the M14 versus the AR15 with respect to reliability, durability, and maintenance.

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[20] USACDC Rpt on Evaluation of Rifles, forwarded by Ltr, CDCRE-E, Hq, USACDC, 14 Dec 62, sub: Rifle Evaluation (as amended) by Staff Paper, CDRG-SP-ITO, 20 Feb 63, sub: Re-evaluation of a Rifle Comparison).

To compare the performance of units armed with the M14 versus the AR15 with respect to hit probability and fire distribution under a variety of tactical conditions.

To compare the M14 versus the AR15 with respect to ease of training.

To compare the M14 versus the AR15 by determining the opinions of platoon members and of controller and evaluator personnel.

The AR15 was the same basic weapon tested by Development and Proof Services in 1960, with a flash hider and a redesigned safety (selector lever) added to reduce the hazard of unintentional trigger release. Stainless steel 20-round magazines were provided for this test. The standard production model M14 was used for comparison. Although no lot numbers were reported, the caliber .223 ammunition was manufactured by Remington and probably was loaded with IMR 4475 propellant. The standard 7.62mm NATO round (M80) was used, but no lot numbers were reported.

The tests were conducted to compare the performance of two infantry platoons at each test site. The platoons were identically equipped except for rifles. Each platoon completed training and familiarization firing with its respective rifle and then held a 10-day simulated combat field exercise which included 41 combat firing situations.

Reliability data was not collected uniformly at the six test sites. Fort Irwin recorded all stoppages, including those correctable by immediate action. Alaska recorded only the stoppages that occurred after the first round was fired in each situation. The remaining four test sites recorded only stoppages that were not correctable by the application of immediate action. Malfunctions were not listed by cause, but the report did distinguish between malfunctions caused by "mechanical failure of the weapon (broken parts, failure to feed, faulty magazine, magazine not seated), faulty ammunition, and mechanical failures which were possible results of faulty ammunition (misfire, failure to extract, failure of the bolt to close, double feed, and round jammed)." The results of the tests are tabulated below.

Malfunctions

Location	Rounds Fired	Faulty Ammo (1)	Ammo Failure (2)	Mechanical Failure (3)	Total (4)	Malfunctions Number per 1,000 Rounds (1)	(2)	(3)	(4)
Irwin[a/]									
AR15	99,378	3	692	25	720	.03	7.0	.3	7.2
M14	69,066	4	191	76	271	.06	2.8	1.1	3.9
Carson									
AR15	71,595	4	41	40	85	.06	.6	.6	1.2
M14	57,102		1	10	11	.0	.02	.2	.2
Hood									
AR15	88,568	24	49	61	134	.3	.6	.7	1.5
M14	77,017	1	6	13	20	.01	.08	.2	.3
Carib									
AR15	87,701	17	246	41	304	.2	2.8	.5	3.5
M14	83,799		7	10	17	.0	.08	.1	.2
Alaska									
AR15	91,333	3	104	83	190	.03	1.1	.9	2.1
M14	102,518		20	26	46	.0	.2	.3	.4
Europe									
AR15	97,286	15	89	111	215	.2	.9	1.1	2.2
M14	77,637		8	9	17	.0	.1	.1	.2
Total									
AR15	535,861	66	1,221	361	1,648	.1	2.3	.7	3.1
M14	467,139	5	233	144	382	.01	.5	.3	.8

[a] The evaluation was conducted at Fort Irwin by CDEC personnel assisted by Stanford Research Institute. Since experienced test and evaluation men collected the data reported, the results from Fort Irwin are probably the most valid of the entire test.

Because of the lack of uniformity in collecting and reporting stoppages or malfunctions at the six test sites, it is impossible to make a meaningful comparison between the results reported by each site, or to compare these results with other tests or evaluations. This material can be used only to compare one weapon against another at a given test site. The report divided stoppages and malfunctions into three arbitrary categories: faulty ammunition, possible ammunition failure, and mechanical failure. Because the data are not clear, the malfunctions cited can not be placed into only one of the categories. For example, a mechanical failure, failure to feed (FF), can also be caused by faulty ammunition (light propellant load or blown primers). On the other hand, some mechanical failures may be the result of faulty ammunition. For example:

A failure to extract (FX) malfunction; this malfunction can also be caused by a broken or worn extractor, a broken or defective extractor spring, a dirty or rusty chamber, or a loose gas plug screw (on the M14 or M1).

A failure of the bolt to close (FBC) malfunction; this malfunction can also be caused by a broken or weak action spring, a dirty rifle, or the firer "riding the bolt forward".

A double feed (DF) malfunction; this malfunction is almost always caused by a defective magazine, and thus the ammunition used would have no bearing on the problem.

In short, the only meaningful data in the table above is the total malfunction rate per 1,000 rounds for each test site for each weapon. The malfunction rate per 1,000 rounds by malfunction category was included here only to show what was reported.

A USAIS TEST

The U.S. Army Infantry School (USAIS) Rifle Evaluation, 20 December 1962, was the second test with valid results. The object of this rifle evaluation exercise was "To compare the hit distribution and hit capabilities of (infantry) platoons armed with the AR15, modified M14 and USAIB M14 rifles as a function of squad size of 11 and 6 men."[21]

The test personnel were all given the same training on the weapon system they were to use; the weapons were then fired for familiarization, qualification, and in squad live fire exercises before starting the tactical live fire evaluation. The tactical phase of the evaluation consisted of several live fire situations in movement to contact, attack, and defense. All platoons fired the same target arrays from the same firing positions. The same basic weapon employed in the USATECOM (D&PS) 1960 test -- the AR15 -- was used.

The M14 (modified) and the Infantry Board M14 used were M14's with selector levers and bipods. The Infantry Board M14 also had a pistol grip stock, a forehand grip, and a muzzle break compensator

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21 This is the first test which compared the AR15 with the M14 firing full automatic fire.

(to reduce automatic fire dispersion and recoil). The .223 ammunition, and 7.62mm ammunition used in the evaluation were not identified.

The reliability (malfunction) data was collected at the end of each firing run. It is not clear in the report as to who evaluated a malfunction and determined the cause, the firer or the data collector; nor does the report describe the technical background of the data collectors. The following malfunction data was reported:[22]

Weapon	Rounds Fired	Total Malfunctions	Malfunctions per 1,000 Rounds
AR15	35,196	65	1.8
M14's[a]	58,157	18	.3

[a] Includes both the modified M14 and the USAIB M14.

The data presented are valid for comparison of the weapons in this test; however, the malfunction rates per 1,000 rounds are unusually low compared to other tests conducted during the same period. Since the determination of weapons reliability was not the primary purpose of the evaluation, many weapon malfunctions are believed to have gone undetected because of the method of data collection or the lack of technical knowledge of the data collectors. A Department of the Army Inspector General investigation, made to

[22] For a detailed breakout of malfunctions reported, see Inclosure 6-2, Table 7.

determine whether this evaluation was reported in an unbiased manner, concluded that data were collected in an unbiased manner, but that some bias in favor of the M14 was evident in the evaluation of the basic data.[23]

A USATECOM TEST

The U.S. Army Test Evaluation Command Report on Comparative Evaluation of the U.S. Army Rifle, 7.62mm, M14; the Armalite Rifle Caliber .223, AR15; and the Soviet Assault Rifle, AK47, 12 December 1962, consisted of three separate evaluations. The purpose of the report was to provide a technical evaluation of the three weapon systems simultaneously. Previous tests of the weapons "were not necessarily representative of current production, capabilities, and requirements, and were not always conducted concurrently with tests of the M14 rifle. . . . In compliance with specific instructions . . . maximum effort was exerted to eliminate subjective considerations and full cooperation was extended to specified industry representatives who were invited to witness all phases of the testing. The reliability data in the report came from the U.S. Army Infantry Board, Fort Benning, Georgia; the U.S. Army Arctic Test Board, Fort Greely, Alaska; and the U.S. Army Development and Proof Services, Aberdeen Proving Ground, Maryland. Although the Soviet AK47 assault rifle was included in the overall

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[23] Rpt of Investigation Concerning the Comparative Evaluation of the AR15, M14, and AK47 Rifles, 8 Mar 63.

evaluation, its reliability data will not be given here since it is not germain. The results of the three separate USATECOM tests are evaluated below

A USAIB TEST

The U.S. Army Infantry Board Report of Project 300, Comparative Evaluation of AR15 (Armalite) and M14 Rifles, 7 December 1962, presented the results of the third test. The purpose of the evaluation was "To compare under temperate environmental conditions the AR15 (Armalite) rifle and the M14 rifle in the rifle, automatic rifle, and submachine gun roles. . . ." Tests for which reliability data were reported, included those for known distance semiautomatic fire accuracy, known distance automatic fire accuracy, trainfire, combat firing, quick fire and penetration, and bullet deflection.

The same basic AR15 and the M14, M14(M), and M14 (USAIB) employed in the Development and Proof Services test were used in the Infantry Board test. The caliber .223 ammunition used was manufactured by Remington but no lot number was reported. Ball cartridge 7.62mm, M80, Lot FC1907, was used for the test.

The reliability data reported were as follows:[24]

Weapon	Rounds Fired	Total Malfunctions	Malfunctions Number per 1,000 Rounds
AR15	43,600	248	5.7
M14 a/	89,300	25	.3

[a] Includes all M14, M14(M), and M14(USAIB) firings.

[24] See Inclosure 6-2, Table 7, for detailed malfunction data.

The report attributed 178 of the 179 failures to feed (FF) to the AR15 magazines. It is possible that the majority of the 48 failures of the bolt to remain to the rear after the last round is fired (FBR) malfunctions were caused by the AR15 magazines. The 5.56mm ammunition is also suspect. There were 29 bullets left in the bore when rounds were extracted, and two blown primers were identified during the tests. Since the report gave no description of how the malfunction data were obtained during the tests, it is assumed that both weapons were assessed in the same manner, and that the tests provide a valid comparison of reliability.

A SECOND ARCTIC TEST

The U.S. Army Arctic Test Board Report of Test of Project ATB 33-001 — Comparative Evaluation of AR15, M14, and AK47 rifles and M79 Grenade Launcher, 1 December 1962, provided results of the fourth test used here. The purpose of the test was to compare the three rifles under Arctic conditions with respect to assembly and disassembly, known distance semiautomatic and automatic firing, penetration of various materials, accuracy, field firing, adverse conditions, position disclosure, reliability, and maintenance. The same basic AR15 and M14 previously tested by D&PS in 1960 were used. The test report did not identify the lot numbers of the 5.56mm caliber .223 or 7.62mm ammunition used. Further, the report did not contain a detailed listing of malfunctions by type. The total number of malfunctions for each weapon was stated for the 10,000-round durability firing as follows:

Weapon	Rounds Fired	Malfunctions Total Number	Malfunctions Number per 1,000 Rounds
AR15	10,000	217 (173)[a]	21.7 (4.4)[b]
M14	10,000	137 (92)[b]	13.7 (4.5)[b]

[a] Number in parenthesis shows the number of malfunctions for each rifle that were attributable to reported magazine difficulties. M14 magazines used were the ones used in the original M14 service tests in 1954-55. The difficulties with the AR15 magazines became negligible after the follower spring was modified and the bolt lubricated.

[b] Malfunction rate in parenthesis indicates what the rate would be if the magazine-induced malfunctions were disregarded.

The report is considered a valid comparison of reliability between the two weapon systems.

A SECOND D&PS TEST

The Development and Proof Services Report on Comparative Evaluation of AR15 and M14 Rifle, Report D&PS 799, 5 December 1962, gave results of the fifth test used here. The purpose of the test was to compare the two weapons with respect to weight and measurements, disassembly and assembly, accuracy (various modes of fire and conditions), brush deflection, adverse conditions, and sustained rate of fire. The same basic AR15 and M14 previously tested by D&PS in 1960 were used. Caliber .223 ball ammunition, Lot Z19I and Lot Z19I modified, containing IMR 4475 propellant was used. (The modification consisted of making a cut approximately ½-inch deep in the nose of the bullet.) The caliber .223 tracer used was Lot Z19C loaded with IMR 4475 propellant.

The 7.62mm M80 ball ammunition, lot numbers WCC6007 and FC1907, was used.

The following reliability data were reported:[25]

Test	Weapon	Rounds Fired	Total Malfunctions	Malfunctions Number per 1,000 Rounds	
1. Miscellaneous: velocity, accuracy, flash and smoke, sound, cook off	AR15	4732	74[a]	15.6	(8.7)[b]
	M14	5485	38	6.9	
2. Adverse conditions: unlubricated, extreme cold, dust, mud, rain	AR15	2340	149[c]	63.7	(37.6)[d]
	M14	3097	62	20.0	
3. Sustained fire	AR15	567	29	51.1	
	M14	537	1[e]	1.9	
4. Total — all tests	AR15	7639	252 (158)[f]	33.0	(20.7)[g]
	M14	9119	101	11.0	

a Includes 33 failures to feed (FF) when one weapon was fired with a missing gas tube pin. When the pin was replaced, the weapon functioned normally.

b Malfunction rate not counting the 33 FF's noted above.

c Includes 61 failures to fire (FFR) caused by separated primers.

d Malfunction rate not counting the 61 FFR's noted above.

e The M14 ruptured a barrel on the 473d round of the 500-round sustained fire test.

f Indicates the total number of malfunctions less the 33FF's and 61 FFR's described in a and b.

g Malfunction rate not counting the 33 FF's and 61 FFR's.

25 See Inclosure 6-2, Table 8, for detailed malfunction data.

The report is considered a valid comparison of reliability between the two weapon systems when the 33 failures to feed, caused by a missing part (which should have been detected by test personnel), and the 61 failures to fire, caused by faulty ammunition, are deducted from the total malfunctions charged to the AR15. The results contained in this report can be directly compared to the AR15 reliability reported in the Development and Proof Services 1959 and 1960 tests, except in the case of the sustained fire test, which was not run in 1959 and 1960.

SUMMARY

In general terms, the tests conducted during 1962-63 indicated that the AR15 experienced about twice the malfunction rate per 1,000 rounds as did the M14. These tests further identified faulty magazines and faulty ammunition as the major contributors to the malfunction of the AR15 system. A summary of the test results during the period is given below.

Table 6-3 — SUMMARY OF AR15 and M14 TEST RESULTS
1962-1963 COMPARATIVE EVALUATION

Test	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
USACDC December 1962	AR15	535,861	1,648	3.1
	M14	467,139	382	.8
USAIS December 1962	AR15	35,196	65	1.8
	M14	58,157	18	.3
USAIB[a] December 1962	AR15	43,600	248	5.7
	M14	89,300	25	.3
USA Arctic Test Bd[a] December 1962	AR15	10,000	217	21.7
	M14	10,000	137	13.7
D&PS December 1962	AR15	7,639	252	33.0
	M14	9,119	100	11.0
Total — all tests	AR15	632,296	2,430	3.8
	M14	633,715	662	1.0

[a] These tests are part of the USATECOM Letter Rpt on Comparative Evaluation of U.S. Army Rifle, 7.62mm, M14; Armalite Rifle, Caliber .223, AR15; Soviet Assault Rifle, AK47, 12 Dec 62.

Analysis of the malfunctions experienced during the period indicates that failures to feed accounted for over 52 percent of the total, failure of the bolt to remain to the rear, 17 percent, and failure to fire, 12 percent. The percentage of the total malfunctions, by type, in firing 86,435 rounds is indicated below.

Table 6-4 — SUMMARY OF AR15 MALFUNCTIONS BY TYPE
1962 - 1963 Comparative Evaluation

Type of Malfunction	Number	Percentage of Total Malfunctions	Occurrence per 1,000 Rounds
Failure to feed (FF)	298	52.74	3.45
Failure of bolt to remain rear (FBR)	98	17.35	1.13
Failure to eject (FJ)	40	7.08	.46
Failure to fire (FFR)	71	12.57	.82
Failure to extract (FX)	14	2.48	.16
Bolt overrides base of round (BOB)	1	.18	.01
Double feed (DF)	2	.35	.02
Broken part (BP)[a]	4	.71	.05
Failure of bolt to close (FBC)[b]	11	1.95	.13
All other malfunctions	26	4.60	.30
Totals	565	100.00	

[a] Includes defective part (DFP), inoperative part (IP), and damaged part (DP).

[b] Includes failure to strip round from magazine and failure to lock.

The 1963-1964 Period of Testing. During this period the AR15 was under detailed scrutiny. It was subjected to numerous tests and several improvements were proposed for both the rifle and its ammunition. Since the ammunition had been charged with many of the malfunctions experienced by the system, on 27 February 1963 the Commanding General, U.S. Army Materiel Command (USAMC), wrote to the Commanding General, U.S. Army Weapons Command (USAWECOM), directing USAWECOM and the U.S. Army Munitions Command (USAMUCOM) to take necessary action to identify problems in weapon and ammunition compatability, and to begin corrective action. Specific problems cited in the letter were:

Raised and uneven primers
Inaccurate primer staking
Bullets inadequately crimped to the cartridge case
Excessive chamber pressures
Sluggish functioning of weapons possibly due to wrong pressure curve
Different cartridge and chamber dimensions.

There were eleven test reports that provided usable reliability data from 1963 to 1964.

THE SPRINGFIELD ARMORY TEST

The Springfield Armory Test Report: Engineering Evaluation of the AR15 Rifle, 21 March 1963, was the first. Its purpose was to determine the "seriousness of AR15 deficiencies as reported from tests by various worldwide agencies" and to recommend improvements to the system. No control weapons were used in the evaluation. The same AR15 configuration that was tested in the 1962 comparative evaluation of the AR15, M14, and AK47 was used. Two lots of caliber .223

Remington ammunition were used: Lot RA5024 and an unnumbered lot.

The propellant loaded in the ammunition was IMR 4475.

The reliability data were obtained from firings in the following tests:

A 280-round modified weapons performance test was conducted with each of the weapons, using each of the six magazines furnished, to determine the basic function problems in the weapons. The firing schedule for a modified weapons performance test is:

40 rounds, semiautomatic
40 rounds, spasmodic
40 rounds, automatic
20 rounds, loose hold, semiautomatic
20 rounds, loose hold, automatic
20 rounds, loose hold, rotated 90 degrees right, semiautomatic
20 rounds, loose hold, rotated 90 degrees left, semiautomatic
20 rounds, loose hold, rotated 90 degrees right, automatic
20 rounds, loose hold, rotated 90 degrees left, automatic
40 rounds, automatic

The results of the test were:[26]

		Malfunctions	
Weapon	Total Rounds Fired	Total Number	Number per 1,000 Rounds
AR15	3,736	47	12.6

26 See Inclosure 6-2, Table 9, for detailed malfunction data.

This test is considered a valid evaluation of the AR15 system reliability. The following recommendations were made by Springfield Armory in the report:

> The tests conducted at Springfield Armory indicate that design studies and product improvement of the weapon are required in the following areas:
>
> Magazine — this requires a complete design study to eliminate feeding malfunctions.
>
> Barrel feed ramps — to prevent stubbed rounds.
>
> Upper receiver — to provide ejection in the 1:00 to 2:00 o'clock direction.
>
> Barrel bullet seat and forcing cone area — to prevent debulleting rounds.
>
> Charging handle — to provide a bolt assist feature so ammunition can be manually chambered.
>
> Inspection of the weapon in the areas reported deficient in the Worldwide Evaluation Test but not encountered during the Springfield Armory test, indicates the following minor product improvement of the weapon is desirable:
>
> Redesign forward receiver pivot pin so that it is not removed from the lower receiver during disassembly. This will prevent the pin from becoming lost.
>
> Redesign trigger pin so both legs of the hammer spring are used to retain the pin, thus preventing it from loosening.
>
> Increase the engagement between the hammer pivot pin and hammer pivot pin retaining spring to prevent the hammer pin from falling out.

Place steel bushings in the upper and lower receiver holes for the take down pin to prevent wear, causing looseness of the pin.

Provide a tool for adjusting the front and rear sights when zeroing the weapon.

THE USMC COMPARATIVE EVALUATION

The second test was the U.S. Marine Corps Comparative Evaluation of M14 Rifle and AR15 Rifle, February - March 1963. The purpose was "To conduct a thorough comparative evaluation of the M14 rifle (including M14(M) and USAIB) and the AR15 (Armalite) rifle, to determine which rifle best suits the requirements ot the Marine Corps for a standard rifle."

The evaluation used two platoons of a regular Maring Corps company at Camp Lejeune, N. C., and 30 Marine recruits at Parris Island, S. C. Both groups underwent preliminary rifle instruction for the weapons, and completed practice and record runs on the standard known distance rifle and automatic rifle qualification courses. In addition, the two platoons at Camp Lejeune conducted extensive field firing exercises in attack and defense, both day and night, to determine relative hit capability and probability for the weapons. Armorers collected and reported malfunction data for all rifles during all live firing. At Camp Lejeune the evaluation was conducted in phases as indicated below:

Three identical phases of test (Phases A, B, and C) were conducted, which included known distance marksmanship and field firing.

Phase A 6-22 February 1963

Phase B 25 February - 7 March 1963

Phase C 12-20 March 1963

During Phase A, one Table of Organization rifle platoon was armed with the M14 rifle and one was armed with the AR15 rifle. For Phase B, these platoons exchanged weapons. New weapons were issued for Phase C and the platoons were equipped the same as for Phase A.

At Parris Island, all firings were conducted with the new weapons and ammunition during the period 25 February - 8 March 1963. The conclusions of the evaluation on reliability were stated as follows:

Reliability.

Weapon. That the AR15 rifle, manufactured to specifications and strict quality control, is equal to the M14 rifle in operational reliability.

Ammunition. That the .223 caliber bullet, manufactured to strict quality control, is equal to the 7.62mm bullet in operational reliability.

Spare Parts Usage. That there is no significant difference in the amount of spare parts usage between the AR15 rifle and the M14 rifle.

Maintenance. That there is no significant difference in the amount of maintenance or the time required for maintenance between the AR15 rifle and the M14 rifle.

During Phases A and B at Camp Lejeune, the AR15 used was the same as that used in the 1962 Army evaluation of the AR15, M14, and AK47. In Phase C at Camp Lejeune, and during all firings at Parris Island, new weapons were used. These new rifles were modified as follows:

All bullet seat angles were modified from 5° included angle to 2° 27' 30.

All magazines supplied were aluminum and included music wire springs instead of stainless steel.

The bolt catch spring was modified to maintain a .7 lb. load at assembled height.

The front sight post height was reduced by .040 of an inch.

Ejector springs were individually tested in each rifle to maintain a load at assembled height of 5 and 3/4 lbs. to 6 lbs.

All gas keys were sealed to prevent possible leakage between the key and bolt carrier.

While this was not a modification to the rifle as such, new function firing procedures were employed with emphasis on the test of the bolt to remain open after the last shot.

The M14 used was the standard M14. The modified M14 (M14(M)) and the M14 (USAIB) used were the same as those previously described. Caliber .223 ball ammunition (Lot Numbers RA223-B2, RA223-B6, and RA223-B7) was used for Phases A, B, and C, respectively, at Camp Lejeune. Lot Number RA223-B7 was the only lot used at Parris Island. All lots were loaded with IMR 4475 propellant. Caliber 7.62mm ball M80 (NATO) ammunition, Lot Number WRA 22174, was used for Phases A and B at Camp Lejeune; Lot Number DAQ 44011 was used for Phase C at Camp Lejeune and for all firing on Parris Island.

The results of the tests were as follows:[27]

Phase	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
Phase A	AR15	50,800	809	15.9
	M14	47,800	102	2.1
Phase B	AR15	49,300	323	6.7
	M14	46,600	189	4.1
Subtotal[a/]	AR15	100,100	1,132	11.3
	M14	94,400	291	3.1
Phase C	AR15	50,500	59	1.2
	M14	46,800	258	5.5
Parris Island	AR15	4,200	12	2.9
	M14	4,200	1	.2
Subtotal[b/]	AR15	54,700	71	1.3
	M14	51,000	259	5.1
Total	AR15	154,800	1,203	7.8
	M14[c/]	145,400	550	3.8

[a] Firings with original rifles (M14 and AR15) and average to poor quality ammunition.

[b] Firings with new M14's and modified AR15 and with good quality ammunition.

[c] All M14 data displayed includes data for M14, M14(M), and M14 (USAIB).

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27 See Inclosure 6-2, Table 10, for detailed malfunction data.

The evaluation is considered a valid comparison of weapons reliability between the two systems. The evaluation gives some insight into the sensitivity of the AR15 system to the quality of its ammunition. During Phases A and B, the unmodified AR15 using fair to poor grade ammunition demonstrated a malfunction rate almost four times that of the M14. When the AR15 was modified to correct some deficiencies noted in previous tests, as indicated above, and good quality ammunition was provided for Phase C, the Parris Island firings, the reliability improved dramatically from an 11.3 rate per 1,000 rounds for Phases A and B to a 1.3 rate per 1,000 rounds for Phase C and Parris Island. Examination of the data reveals that the change in the magazines for the Phase C and Parris Island firings reduced the failures to feed (FF) from 409 (for Phases A and B) to 12; reduced the failures from defective magazines from 132 (for Phases A and B) to 5; and contributed, along with the change in the bolt catch spring, to reducing the failures of the bolt to remain to the rear (FBR) from 481 (for Phases A and B) to 23.

The evaluation did not include technical, environmental, or adverse conditions tests. Further, all weapons were cleaned daily, and seldom fired more than 200 rounds per weapon per day. The report did state, however, that blowing sand had become a problem for the M14 during the tests. Of the 258 M14 stoppages in Phase C, . . .

> 256 were primarily attributed to blown sand while firing. . . . This blown sand condition did

not prevail for the firing of the AR15 during Phase C. During Phase B, however, both rifles were subjected to a similar blown sand condition when firing over the same course, and 110 stoppages were recorded for the M14 rifle because of sand with no ill effects from sand noted with the AR15 rifle.

THE USATECOM TEST OF RIFLING TWIST

The U.S. Army Test and Evaluation Command (D&PS) Report on Evaluation Test of the Rate of Rifling Twist in Rifle, Caliber .223, AR15, April 1963, presented results of the third test. The purpose of the evaluation was "to determine the effect of rate of twist on accuracy, reliability, bullet stability, and endurance." Four AR15 rifles, two with 1:14-inch twist rate and two with 1:12-inch twist rate, were fired. An M14 rifle was used as a control weapon.[28] The test consisted of firings for velocity, accuracy, and endurance, under controlled conditions.

The same AR15 configuration that was tested in the comparative evaluation of the AR15, M14, and AK47 was used, except that two of the weapons had 1:12-inch twist rate barrels. The standard M14 manufactured by Harrington and Richardson Arms Company was used. Caliber .223mm ball cartridge, Lot RA5024 (Z01M), loaded with IMR 4475 propellant, and caliber 7.62mm ball cartridge NATO M80, Lot FC 1907, were used.

The results of the test were:[29]

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28 All M14's have a 1:12-inch twist rate.

29 See Inclosure 6-2, Table 11, for detailed malfunction data.

Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
AR15	25,850	429	16.6
M14	6,622	16	2.4

The results of this test make a valid comparison of the reliability of the AR15, as it was configured at that time, and the M14. Since weapons performance under adverse conditions was not assessed during this test, the malfunction rates reflected are those which could be expected under ideal conditions. The results are comparable only to similar tests run by D&PS.

THE USAIB TEST OF THE BOLT ASSIST

The results of the fourth test used appeared in the U.S. Army Infantry Board Report of Product Improvement Test of Armalite AR15 Rifle (Test of Bolt Assist Device), 30 August 1963. The purpose was to determine the suitability of the proposed bolt closure device, and no control weapons were used. The test concluded that "the modified AR15 rifle did not show significant improvement in reliability over the AR15 rifle used in the previous project."

The modified AR15 used in this test differed from the rifles tested in November-December 1962 in that a bolt assist device, which was built into the charging handle and the upper receiver, had been added. Aluminum magazines of a new design were also provided for the test. The 5.56mm ammunition used in the test was not identified.

The reliability data were obtained from firings conducted in the following exercises:

a. Exercise I — The three modified AR15 rifles were fired at the rate of 40 rounds per minute for 5 minutes, then allowed to cool. The rifles were then fired at a rate of 15 rounds per minute for 200 rounds, allowed to cool, and then cleaned.

b. Exercise II — The three modified AR15 rifles were exposed to settling dust as might be encountered in a convoy on a dusty road, after which they were wiped off, fired at the rate of 40 rounds per minute for 5 minutes, allowed to cool, and then cleaned.

c. Exercise III — The three modified AR15 rifles were fired at the rate of 40 rounds per minute for 5 minutes, allowed to cool, and then cleaned. The rifles used in this exercise had a liberal coat of oil on the bolt and bolt carrier.

d. Exercise IV — The three modified AR15 rifles were submerged in water, then withdrawn and wiped as dry as would be practical in a hurried field situation. The rifles were then fired at a rate of 40 rounds per minute for 5 minutes, allowed to cool, and then cleaned.

The results of the test were:[30]

		Malfunctions	
Exercise	Rounds Fired	Total Number	Number per 1,000 Rounds
I	(1,200)[a]	7	(5.8)[b]
II	(600)	7	(11.7)
III	(600)	10	(16.7)
IV	(600	7	(11.7)
Total	2,886[c]	31	10.7[d]

[a] Numbers in parenthesis indicate rounds scheduled to be fired in each exercise. (Actual number fired was not stated.)

[b] Rates in parenthesis indicate what the malfunction rate would be if all scheduled rounds were fired.

[c] Actual total rounds fired for all exercises.

[d] Actual malfunction rate for all exercises.

[30] See Inclosure 6-2, Table 12, for detailed malfunction data.

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Of the 31 total malfunctions, 58 percent or 18 malfunctions were failures to feed (FF or FF-1). The malfunction rate was considerably higher than previously experienced except where all adverse conditions (dust, unlubricated, mud, rain, and extreme cold) were tested. The results of this test are not directly comparable to any test conducted before.

THE USAIB TEST OF THE BOLT CLOSURE DEVICE

The U.S. Army Infantry Board Product Improvement Test of the Armalite AR15 Rifle, 14 October 1963 furnished the results of the fifth test.[31/] The purpose was to determine the suitability of the proposed bolt assist device. No control weapons were used. The conclusion was: "The bolt assist device used in the test provides an adequate but not optimum means of closing the bolt of the AR15 rifle in event of a stoppage."

The modified AR15 used differed from the rifles tested in November-December 1962 in that a bolt assist device had been added to the side of the upper receiver. It consisted of a housing and a spring-loaded plunger (pawl) assembly which, when pushed, engaged vertical notches cut in the side of the bolt carrier and forced the bolt and bolt carrier forward into the locked position. The 5.56mm ammunition used in the test was not identified.

The reliability data were obtained as follows.

> a. Testing of the most recently modified AR15 rifles was conducted on 2 October 1963. Four AR15

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[31] USAIB Second Letter Report of Test Results - Product Improvement Test of the Armalite AR15 Rifle (Test of Bolt Assist Device), 14 October 1963.

rifles with the side mounted bolt assist device were used in each of the following exercises. (Three of the rifles used had the housing mounted on the right side of the receiver and one of the housings mounted on the left side.)

(1) Exercise I — The four modified AR15 rifles were fired at the rate of 40 rounds per minute for 5 minutes, allowed to cool, and were then cleaned.

(2) Exercise II — The four modified AR15 rifles were exposed to settling dust as might be encountered in a convoy on a dusty road, after which they were wiped off as would be practical in a hurried field situation, fired at the rate of 40 rounds per minute for 5 minutes, allowed to cool, and then cleaned.

(3) Exercise III — The four modified AR15 rifles used in this exercise had a liberal coat of oil on the bolt and bolt carrier. The rifles were then submerged in water, withdrawn, and wiped as dry as would be practical in a hurried field situation, after which they were fired at a rate of 40 rounds per minute for 5 minutes.

The results of the test are tabulated below.[32]

		Malfunctions	
Exercise	Rounds Fired	Total Number	Number per 1,000 Rounds
I	(800)[a]	5	(6.3)[b]
II	(800)	10	(12.5)
III	(800)	13	(16.3)
Total	2,465[c]	28	11.4[d]

[a] Number in parenthesis indicates rounds scheduled to be fired in each exercise (actual number fired was not stated).

[b] Rates in parenthesis indicate what the malfunction rate would be if only scheduled rounds were fired.

[c] Actual total rounds fired for all exercises.

[d] Actual malfunction rate for exercises.

[32] See Inclosure 6-2, Table 13, for detailed malfunction data.

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Sixty-four percent or 18 of the 28 malfunctions were failures to feed (FF or FF-1). Exercises I and II of this test are comparable to Exercises I and II of the USAIB 30 August 1963 test of another type of bolt assist device. The overall malfunction rate experienced in this test was higher by .7 per 1,000 rounds than in the previous test.

THE USATECOM TEST OF BOLT ASSIST DEVICES

The U.S. Army Test and Evaluation Command Report on the Product Improvement Test of Bolt Assist Devices for Rifle, Caliber .223, AR15, Report DPS-1120, November 1963, was the sixth test. The purpose of the test was to evaluate two different designs of bolt assist devices - a modified charging handle device and a side mounted plunger device. The conclusion of the report was that only the side mounted plunger device "provided an effective means for closing the bolt under adverse conditions." No control weapons were used in the evaluation.

The same basic AR15 weapon that was tested in the comparative evaluation of AR15 and M14 rifles, DPS Report No. 799, December 1962, was used except that three of the weapons had modified charging handle bolt assist devices, and two weapons had the side mounted bolt assist device. The 5.56mm ammunition used was the ball cartridge caliber .223, identified as RA5024, which included Lots Z16M, Z015M, and Z01M containing IMR 4475 propellant.

The reliability data was obtained during D&PS standard adverse conditions tests (unlubricated, dust, mud, extreme cold, and cook off).

The results of the test were as follows:[33]

Test	Weapon[a]	Rounds Fired	Malfunctions[b] Total Number	Number per 1,000 Rounds
Unlubricated	C	180	-	.0
	P	120	2	16.7
Dust	C	180	22	122.2
	P	120	25	208.3
Mud	C	180	204	1,133.3
	P	120	216	1,800.0
Cold (-65°)	C	1,800	83	46.1
	P	1,200	65	54.2
Cook Off	C	797	29	36.4
Total	C	3,137	338	107.7
	P	1,560	308	197.4
	All	4,697	646	137.5

[a] Weapon code: C = AR15 with modified charging handle bolt assist device; P = AR15 with side mounted plunger bolt assist device.

[b] High malfunction rates in adverse conditions tests are not uncommon because multiple malfunctions can and do occur in firing one round. For example, a failure to feed, a failure to extract, and a failure of the bolt to remain to the rear could occur.

This test is considered valid and comparable with other USATECOM (D&PS) tests when the weapons were subjected to the same adverse conditions. It is noteworthy that a lower malfunction rate

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[33] See Inclosure 6-2, Table 14, for detailed malfunction data.

was experienced by the AR15 equipped with the modified charging handle bolt assist device than by the AR15 equipped with the plunger bolt assist device, which was eventually adopted for the Army.

THE USAIB TEST OF THE BOLT ASSIST DEVICE

The U.S. Army Infantry Board Letter Report of the Product Improvement Test of XM16 Rifles, 4 December 1963, recorded the results of the seventh test used here. The purpose was to determine (1) if the enlarged striking surface of the plunger[34] on the bolt assist device was adequate; (2) the suitability of an enlarged charging handle to increase leverage for opening the bolt in the event of certain stoppages; and (3) the suitability of a modified firing pin, designed to prevent inadvertent firing. The test concluded that all three modifications were adequate to perform their intended tasks. No control weapons were used.

The AR15 had been classified limited production (LP) for the Army in early December 1963 as the XM16. This was the basic rifle tested in the 14 October 1963 USAIB test with the following modifications: (1) the bolt assist device had an enlarged striking surface on the plunger cap; (2) the charging handle had been expanded at the rear in width and thickness to increase leverage for opening the bolt; and (3) the shoulder of the firing pin had been reduced in size and a coil spring had been added to prevent forward movement until the pin was struck by the hammer. The 5.56mm ammunition used in the test was not identified.

The reliability data was obtained as follows:

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34 Recommended in the USAIB, 14 October 1963, report.

(1) Test I - The nine XM16 rifles were fired at the rate of 40 rounds per minute for 5 minutes, allowed to cool, then fired at the rate of 15 rounds per minute for 200 rounds and allowed to cool The rifles were then cleaned and oiled.

(2) Test II - The XM16 rifles were exposed to settling dust as might be encountered in a convoy, wiped off under hurried field conditions, fired 40 rounds per minute for 5 minutes, allowed to cool, then were cleaned and oiled.

(3) Test III - A liberal coat of oil was applied to the firing mechanisms of the rifles, after which they were submerged in water, wiped off under hurried field conditions, fired 40 rounds per minute for 5 minutes, and allowed to cool. They were then cleaned and oiled.

The results of the tests were as follows:[35]

		Malfunctions	
Test	Rounds Fired	Total Number	Number per 1,000 Rounds
I	3,600	2	.6
II	1,800	17	9.4
III	1,800	11	6.1
Total	7,200	30	4.2

The results of this test are comparable to the USAIB test data of 14 October 1963. Failure to feed (FF or FF-1) malfunctions accounted for 53 percent or 16 of the 30 malfunctions experienced. The overall malfunction rate was only 37 percent of that experienced in the previous test. This is the first test of this series that did not report a failure to extract (FX) malfunction.

THE USAF TEST OF FIRING PINS

The U.S. Air Force Marksmanship School Evaluation of M16 Modification - Firing Pin Retaining Devices, 6 December 1963, was the

[35] See Inclosure 6-2, Table 15, for detailed malfunction data.

eighth test evaluation used here. The purpose of the test was to evaluate the effectiveness of two designs of firing pins in reducing firing pin energy upon closure of the bolt in the M15 (AR15) rifle. The conclusions of the test indicated that both of the modified firing pins would introduce a greater probability of misfire than of inadvertent fire. No control weapons were used in the evaluation. The AR15 configuration was the same as that tested in the 1962 comparative evaluation of the AR15, M14, and AK47 except for the modified firing pins. The 5.56mm ammunition used was not identified in the report.

The reliability data was obtained from firing approximately 7,000 rounds in each of five weapons. The mode of fire and firing schedule were not described. Each weapon was cleaned, lubricated, and inspected after each 1,000 rounds.

The results of the test were as follows:[36]

Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
M16(AR15)	35,885	48	1.3

Since the purpose of the test was to evaluate two types of firing pin retaining designs to preclude inadvertent fire upon closure of the bolt, most, if not all, firings were probably semiautomatic. Further, the weapons were not subjected to any adverse conditions, and were cleaned and lubricated after each 1,000 rounds. The resulting malfunction rate, therefore, is one that could be expected

36 See Inclosure 6-2, Table 16, for detailed malfunction data.

under ideal conditions. It is important that one-third of the 48 malfunctions experienced were caused by broken parts, a dramatically higher parts mortality rate than had ever been experienced before with the M16 system. The test report noted the high incident of parts breakage and found that the modified firing pin adversely affected the reliability of the system. The results of this test are not directly comparable to any test conducted prior to December 1963.

THE USATECOM PROPELLANT TEST

The U.S. Army Test and Evaluation Command (D&PS) Engineer Design Test of Alternate Propellants for Use in the 5.56mm Ball Cartridge, M193, April 1964, was the ninth test. Its purpose was to provide Frankford Arsenal with ballistic data on four lots of 5.56mm ammunition loaded with four different propellants, and the results were included in the Frankford Arsenal report. The AR15 used was identified only as a caliber .223 rifle, Colt, AR15, model 02. Presumably the weapons tested had a 1:12-inch barrel twist.[37/]

The ammunition used was 5.56mm ball cartridge, M193, with the following lot numbers:

RA-223-103, loaded with WC846 propellant
RA-223-104, loaded with HPC-10 propellant
RA-223-105, loaded with IMR 4475 propellant
RA-223-106, loaded with EX8136-1 propellant

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37 Only 27,500 1:14-inch twist rifles were made, and the serial numbers of the 16 rifles used in the test are in the 31,000 to 35,000 blocks.

Firings were conducted to provide information on smoke, flash, fouling, and erosion. Each weapon first fired 1,500 rounds without cleaning in the fouling test. Only one of the twelve weapons experienced a stoppage attributable to fouling. After lubrication of the bolt cam pin, each weapon completed the remaining 4,690 rounds on the endurance schedule without further stoppages. The weapons were cleaned after the fouling tests were completed, and every 1,000 rounds thereafter.

The results of the tests were as follows:[38]

		Malfunctions	
Lot Number[a]	Rounds Fired	Total Number	Number per 1,000 Rounds
RA-223-103(WC846)	13,874	14	1.0
RA-223-104(HPC-10	13,840	2	.1
RA-223-105(IMR 4475)	13,770	2	.1
RA-223-106(EX8136-1)	13,790	20	1.5
Total	55,274	38	.7

[a] Twelve AR15's were used for the tests, three rifles for each lot of ammunition.

These tests were conducted under ideal conditions for purposes other than reliability, therefore the results are comparable only to other tests of the same type conducted by D&PS. It should be noted that 20 of the 38 total malfunctions were experienced by one rifle during the fouling test, using ammunition Lot RA-223-106(EX8136-1).

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[38] See Inclosure 6-2, Table 17, for detailed malfunction data.

THE USATECOM TEST OF VARIOUS COMPONENTS

The tenth test results were contained in USATECOM (D&PS) Report on Product Improvement Test on Modified AR15 Rifles, Report DPS-1276, April 1964. The purpose of this test was "to evaluate the following modifications of the AR15 rifle: (a) bolt closure device (two modifications); (b) charging handle; (c) firing pin (three modifications)."

The test report concluded that:

> a. The frequency of feeding and chambering malfunctions indicates the necessity of a positive method of manually assisting the forward movement of the bolt and bolt carrier assemblies. The bolt closure device . . . was adequate in performing its intended function. . . .
>
> b. The modified charging handle design provides adequate means for retracting the bolt and bolt carrier assemblies. . . .
>
> c. Test data do not indicate a need for a firing pin inertia retarding device. . . .
>
> d. The life of the extractor spring was less than that of other spring components of the AR15 rifle. . . .
>
> e. The magazines supplied with the test weapons caused failures to feed and to chamber. . . .
>
> f. Weakness of the bolt catch spring allowed functioning of the bolt catch before the last round was fired. . . .
>
> g. The energy delivered by the action spring to the bolt carrier during the loading cycle of the weapon appeared to be marginal. . . .

No control weapons were used in the tests. AR15's modified with the side mounted plunger bolt closure device (two configurations), an enlarged charging handle, and three configurations of firing pin inertial retarding devices were used. Five rifles were tested. The ammunition used was 5.56mm ball cartridge, M193, Lot RA-5022, loaded with IMR 4475 propellant.

The malfunction data were obtained during standard adverse conditions tests (extreme cold, extreme heat, rain, dust, and mud) and the standard 6,000-round endurance test.

The results of the tests were as follows:[39]

		Malfunctions	
Test	Rounds Fired	Total Number	Number per 1,000 Rounds
Extreme cold	560	6	10.7
Extreme heat	560	3	5.4
Rain	3,000	40	13.5
Dust	100	0	.0
Mud	134	168	1253.7
Endurance	29,119	626	21.5
Total	33,473	843	25.2

The results of this test are considered valid for comparison with the results of previous adverse conditions and endurance tests on the AR15 conducted by D&PS. Failures to feed (FF, FF-1, SR) accounted for approximately 29 percent of the malfunctions.

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39 See Inclosure 6-2, Table 18, for detailed malfunction data.

Malfunctions of this kind are largely influenced by the quality of the magazines used, and the magazines used in this test were of poor quality

THE USATECOM TEST OF PERFORMANCE VS SPECIFICATIONS

U.S. Army Test and Evaluation Command (D&PS) Final Report of Comparison Test of the Rifle, 5.56mm, M16, Report DPS-1471, October 1964, was the last test used in this period. The purpose was:

> to determine if M16 production rifles conform to the performance specifications and as a quality assurance measure to detect any design, manufacturing, or inspection deficiencies that would adversely affect the operation of the rifles.

e conclusions of the report were:

> a. With the exception of one rifle which failed to meet performance specifications because of excessive failures to fire semiautomatically, all of the rifles tested met . . . performance requirements. . . .
>
> b. In the automatic accuracy and adverse conditions tests . . . no significant design operational deficiences were encountered. . . .

The test consisted of various semiautomatic and automatic accuracy tests, a rate-of-aimed-fire test, adverse conditions tests (extreme cold, unlubricated, mud, rain, dust, and heat and humidity), and the standard 6,000-round reliability test. No control rifles were used in the tests. Production model M16's without a bolt assist device, ball cartridge caliber .223 (5.56mm), Lot RA 5027, loaded with IMR 4475 propellant, were used.

The results of the tests follow:[40]

Test	Weapon	Rounds Fired	Malfunctions Total Number	Malfunctions Number per 1,000 Rounds
Adverse conditions				
Unlubricated	M16	100	0	.0
Dust	M16	20	0	.0
Mud	M16	20	0	.0
Rain	M16	600	13	21.7
Extreme cold	M16	620	27[a]	43.5
Heat and humidity	M16	160	0	.0
Reliability including accuracy	M16	16,812	23	1.4
Total	M16	18,332	63	3.4

[a] Includes 20 failures to extract because of a defective extractor and spring. These were the only failures to extract experienced in the entire test.

The results of this test are considered valid and are directly comparable to previous adverse conditions and reliability tests conducted by D&PS.

SUMMARY

The 1963-64 period of testing was devoted primarily to testing improvements to the AR15 (bolt assist devices, firing pin retarding

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[40] See Inclosure 6-2, Table 19, for detailed malfunction data.

devices, barrel twist rate, and propellants); re-evaluations of the AR15 by the Army; and an evaluation by the U.S. Marine Corps. Since most of the tests were of various modifications, and since problems with ammunition and magazines had not been resolved, the malfunction rates experienced were generally high until the last test of the period, when the rate was 3.4 per 1,000 rounds. One-third of all malfunctions in the final test were caused by a defective extractor and spring on a single rifle. Also during this period the AR15 was classified as limited production for the Army, and was issued to airborne and special forces units as their basic weapon. No major problems were identified with the system by the tests conducted, although several modifications were recommended. See Appendix 2 for a detailed analysis of test procedures. A tabular summary of the 1963-64 period test results is given below:

Table 6-5 — SUMMARY OF AR15 and M14 TEST RESULTS
1963 - 1964

Test	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
Springfield Armory March 1963	AR15	3,736	47	12.6
	—			
U.S. Marine Corps March 1963	AR15	154,800	1,203	7.8
	M14	145,400	550	3.8
D&PS April 1963	AR15	25,850	429	16.6
	M14	6,622	16	2.4
USAIB August 1963	AR15	2,886	31	10.7
	—			
USAIB October 1963	AR15	2,465	28	11.4
	—			
USATECOM November 1963	AR15	4,697	646	137.5
	—			
USAIB December 1963	AR15	7,200	30	4.2
	—			
U.S. Air Force December 1963	AR15	35,885	48	1.3
	—			
USATECOM April 1964	AR15	55,274	38	.7
	—			
USATECOM April 1964	AR15	33,473	843	25.2
	—			
USATECOM October 1964	M16	18,332	63	3.4
	—			
Total — all tests	AR15-M16	344,598	3,406	9.9
	M14	152,022	566	3.7

Analysis of the malfunctions by type experienced during this period indicates an approximate 40 percent reduction in failures to feed but an increase in the failure to extract and failure of the bolt to remain to the rear malfunctions. The percentage of total malfunction, by type, in firing 344,598 rounds is shown below.

Table 6-6 — SUMMARY OF AR15 MALFUNCTIONS BY TYPE, 1963 - 1964

Type of Malfunction	Number	Percentage of total Malfunctions	Occurrence per 1,000 Rounds
Failure to feed[a]	1,002	29.42	2.91
Failure of bolt to remain rear	825	24.23	2.39
Failure to eject	148	4.35	.43
Failure to fire	70	2.05	.20
Failure to extract	344	10.09	1.00
Bolt overrides base of round	80	2.35	.23
Double feed	23	.67	.07
Broken part[b]	41	1.21	.12
Failure of bolt to close[c]	392	11.51	1.14
All other malfunctions	481	14.12	1.40
Totals	3,406	100.00	

[a] Includes failure to feed first round.

[b] Includes defective part, inoperative part, and damaged part.

[c] Includes failure to strip round from magazine and failure to lock.

The 1965-66 SAWS Study Cycle of Tests

This was an active testing period in the life cycle of the M16 system. In addition to the four SAWS Study tests, seven other tests were conducted which provided usable reliability data.

THE USATECOM EVALUATION OF PRODUCTION RIFLES

The USATECOM (D&PS) Final Report of the Comparison Test of the 5.56mm Rifle (8 September - 13 November 1964), January 1965, gave the results of the first of these. The purpose of the test was "to provide an evaluation of production XM16E1 rifles to assure that they conform to the technical requirements of the purchase description Acceptance Testing Specifications and to detect any design, manufacturing, or inspection deficiencies that would adversely affect the operation of the rifles." The reliability data was obtained by subjecting five weapons to various accuracy tests, standard adverse conditions tests,[41] and 6,000-round reliability tests.

The test report offered the following conclusions:

> a. With the exception of one rifle which failed to meet performance specifications because of excessive failures to feed with the cartridge visible, all the rifles tested met the performance requirements. . . .
>
> b. In the adverse conditions testing (no performance requirements delineated) no significant design or operational deficiencies were encountered. . . .

41 Extreme cold, high temperature and high humidity, dust,and mud, rain, and unlubricated weapon.

c. Attachment of the M7 bayonet to the rifle did not change the center of impact of the groups fired or adversely affect the accuracy of the rifle. . . .

d. The bolt-assist assembly provides a ready means of clearing failure to lock and failures to strip malfunctions, and was not detrimental in any way to the use and operation of the rifle during the tests. . . .

A production model of the XM16E1 with a bolt assist device and 1:12-inch barrel twist was used in the test.[42] Ammunition was 5.56mm ball cartridge, caliber .223, Lot numbers RA-5027 and RA-5022. Both lots were loaded with IMR 4475 propellant.

The reliability of the XM16E1 was reported as follows:[43]

Test	Weapon	Rounds Fired	Malfunctions Total Number	Malfunctions Number per 1,000 Rounds
Adverse Conditions				
Unlubricated	XM16E1	100	1	10.1
Dust	XM16E1	20	0	.0
Mud	XM16E1	20	0	.0
Rain	XM16E1	600	6	10.0
Extreme cold	XM16E1	320	2	6.3
Heat and humidity	XM16E1	160	0	.0
Subtotal	XM16E1	1,220	9	7.4
Reliability	XM16E1	15,089	21	1.4
Interchangeability	XM16E1	120	1	8.3
Total	XM16E1	16,429	31	1.9

42 Serial numbers in the 101,000 and 102,000 blocks.
43 See Inclosure 6-2, Table 20, for detailed malfunction data.

THE USATECOM TEST OF THE TRACER CARTRIDGE

USATECOM (D&PS) Final Report of Engineering Test of Cartridge, 5.56mm, Tracer, XM196, Report DPS-1687, (15 July 1964 - 16 March 1965), June 1965, recorded the results of a test "To determine the suitability of the XM196 cartridge for use in the M16 rifle." Firings were conducted for accuracy, trace, cook off, vibration, brush deflection, erosion, penetration, and functioning. The report concluded:

> a. The physical characteristics, trace characteristics and accuracy of the XM196 cartridge complied with (the specifications). . . .
>
> b. A cook off can be expected with either the XM196 or M193 round when more than 120 rounds are fired as rapidly as possible in the M16 rifle.
>
> c. The vibration of the XM196 cartridge caused delays in trace. . . .
>
> d. The erosion characteristics of the XM196 cartridge are comparable to those of the M193 cartridge. . . .
>
> e. The attitude of the weapon does not affect functioning when firing either the XM196 or M193 cartridge. . . .

Four M16 rifles and two XM16E1 rifles were used in the test. The M16 is the standard U.S. Air Force version of the AR15, without the bolt assist device, and the XM16E1 was at that time classified as limited production for the Army and had the bolt assist device. Both weapons had a 1 turn in 12-inch barrel twist. The ammunition used was 5.56mm ball cartridge, M193, Lot RA-5027, and tracer cartridge, XM196, Lot RA-223-115. Both lots were loaded with IMR 4475 propellant.

The reliability data were reported as follows:[44]

Weapon	Serial Number	Rounds Fired	Total Number	Number per 1,000 Rounds
XM16E1	23,295	220	0	.0
XM16E1	23,348	120	0	.0
M16	8,625	140	0	.0
M16	7,239	7,185	16	2.2
M16	7,721	6,300	127	20.2
M16	8,651	6,976	4	.6
	Total	20,941	147	7.0

Of the total malfunctions reported, 86 percent or 127 were experienced with one rifle. Of these, 60 percent or 89 of the total malfunctions were the firing of two rounds on one pull of the trigger and 20 percent or 3 were failures to fire caused by light strikes by the firing pin on the primer. As a result, the overall malfunction rate for the test was 7.0 per 1,000 rounds; it would have been 1.3 per 1,000 rounds without these two malfunctions. Although the primary purpose of the test was to evaluate the performance of the XM196 tracer round, test personnel should have recognized the repetitive malfunctions of the one weapon, and changed the defective parts in the trigger group. It should be noted that 41 of the 44 malfunctions

[44] See Inclosure 6-2, Table 21, for detailed malfunction data.
[45] The F2R malfunctions began at about 700 rounds and continued through the rest of the 6,300 rounds fired by that weapon.

of failure to fire were experienced with the XM196 tracer round, 30 of them in the same weapon, as indicated above. Since the weapons were fired under "ideal" conditions, the firings and malfunctions of that one weapon should be disregarded. The malfunction rate for all other weapons during the test would then be 1.4 per 1,000 rounds, which is considered valid.

THE USATECOM REPORT OF THE SAWS SERVICE TEST

The USATECOM (USAIB) Final Report of SAWS Service Test, USAIB Project 3110, December 1965, furnished results of the Service Test, whose objectives were:

> To measure weapons performance against standards provided by the U.S. Army Combat Developments Command.
>
> To provide . . . data resulting from tests for use in parametric design/operational effectiveness/ cost analysis studies to be conducted by USACDC.
>
> To develop sufficiently comprehensive data, as appropriate, to provide a basis for choice if type classification is desired.

The reliability data were collected during extensive firings by troops in basic marksmanship courses and simulated combat situations, such as attack and defense, both day and night. The weapons were used in the situations firing both semiautomatically and automatically. The data indicated below include firings of the M14 and XM16E1 in only the rifle role.

The XM16E1, M14, and M14E2 rifles used were of the same configuration as those used in the Engineering Test described above. The following ammunition was used in the test:

7.62mm NATO ball cartridge, M80, Lots FA 5374, WRA 22386, LC 12532, LC 12036, and LC 12047. (The last two lots were match grade ammunition.)

7.62mm NATO tracer cartridge, M62, Lot LC 12266.

5.56mm ball cartridge, M193 Lot WCC 6089, RA 5101, RA 5100, and RA 5072. (All lots except RA 5072 were loaded with WC 846 ball propellant; Lot RA 5072 was loaded with CR 8136 IMR propellant.)

5.56mm tracer cartridge, M196, Lot RA 5119, RA 5019, and RA 5018 (all loaded with WC 846 ball propellant).

The reliability of the weapons in the test is indicated below:[46]

		Malfunctions	
Weapon	Rounds Fired	Total Number	Number per 1,000 Rounds
XM16E1	95,720	1,269	13.3
M14	445,268	351	.8

Of the 1,269 XM16E1 malfunctions, 77 percent were attributable to three types of malfunctions: failure of the bolt to remain to the rear (FBR), 42 percent; bolt override of the base of the round (BOB), 15 percent; and failure to eject (FJ), 20 percent. Although

46 See Inclosure 6-2, Table 22, for detailed malfunction data.

the FBR and BOB malfunctions could be partly attributed to the magazines used, they could also be directly related to the rate of speed at which the recoiling parts were operating, as in a high cyclic rate of fire. If the recoiling parts (bolt, bolt carrier, and buffer) are moving fast enough the magazine does not have sufficient time to position the bolt stop and a FBR occurs, or to position the next round in the magazine so that the forward moving bolt will strip it from the magazine properly and a BOB occurs. In addition, an excessively high rate of failure to extract malfunctions occured during the test: 7 percent of the total malfunctions, or one in every 1,113 rounds. These malfunctions may also be partly attributed to fast moving operating parts caused by a high cyclic rate, because if the operating parts initiate extraction before the gas pressure within the cartridge case has had time to dissipate sufficiently, the case is still expanded against the walls of the chamber and an extractor override, or rim shear, may occur and the case will not be extracted. This test does provide a valid comparison of the reliability of the two weapon systems as they were configured at that time (the XM16E1 used primarily ball propellant ammunition and the old buffer design).

THE BARREL EROSION STUDY

The Springfield Armory - U.S. Air Force Barrel Erosion Study of Rifles, 5.56mm, M16 and XM16E1, January 1966, had as its purpose

a. To provide a simple, practical means of determining when the rifle barrel should be replaced, based on the erosion of the barrel bore.

b. To test proposed design changes.

c. To determine parts life of the current design.

d. To determine the malfunction rate and the peculiarities of the weapon resulting from extended firing.

e. To test the cleaning rod, M11, and the bore brush, 11010021, for durability.

Reliability data was obtained by subjecting 12 rifles to various accuracy, velocity, and yaw firings, as well as functional firings under ideal conditions.

The report concluded:

a. The erosion of the bore can be used reliably as one means of determining the need to rebarrel a rifle.

b. A simple, inexpensive, easy-to-use gage can be designed for this purpose.

c. That both the M11 cleaning rod and bore brush, 11010021, (short) are not adequate.

d. The bolt suffered the greatest breakage rate, followed by the extractor spring, ejector spring, hammer spring, action spring guide assembly, and the extractor. These six components accounted for approximately 63 percent of the breakages or unserviceable parts.

e. The "fail to eject" malfunction (42.5 percent) and the "bolt stop" failed to function (40 percent) accounted for 82.5 percent of the total malfunctions encountered during the test.

f. There had been no appreciable loss of velocity when the weapons were rejected for loss of accuracy.

g. The test magazines GX5559, and the 30 round magazine (no number) functioned acceptably but suffered severe pitting after exposure to rain and were not acceptable for this reason. The use of a protective finish would overcome this condition.

h. The bolt carrier, GX5552, was not acceptable due to the reduced service life of 10,000 rounds as compared to the more than 25,000-round life of the standard.

All twelve rifles tested were XM16E1, with bolt closure device a 1 turn in 12-inch barrel twist; six were standard production model XM16E1's and six XM16E1's modified with test components as follows:

Bolt	Spring action
Ejector	Carrier, bolt
Ejector spring	Ejector slot cover assy
Extractor	Hand guard slip ring section
Key, bolt carrier	Spring, weld assy
Pin, extractor	Assembly gas tube
Pin, firing	Seamless, stainless steel tube
Pin, firing pin retaining	Box, magazine with protective finish
Spring, hammer	Box, magazine without protective finish

The test components were replaced with standard components in the event of failure during the test. Ammunition used for accuracy firings was 5.56mm ball cartridge, Lots RA 1-5, RA 1-6, and RA 1-7; Lots WCC 6022 and WCC 6026 were used for function firings. The RA lots were loaded with IMR 4475 propellant and the WCC lots were loaded with WC 846 (ball) propellant.

The reliability was reported as follows:[47]

Weapon	Rounds Fired	Malfunctions Total Number	Malfunctions Number per 1,000 Rounds
Standard XM16E1	172,000	2,491	14.5
Modified XM16E1	156,000	2,033	13.0
Total	328,000	4,524	13.8

Although the test was conducted primarily to determine barrel life and to test some modified components, it does provide malfunction data that can be compared to previous tests. (See Inclosure 6-2, Tables 24 and 25, for detailed malfunction data for the first 6,000 rounds and the first 10,000 rounds of the test, respectively.) Weapons performance varied widely in the percentages of total malfunctions experienced in the first 6,000 rounds (a low of 2.7 percent to a high of 55.1 percent), and those experienced in the first 10,000 rounds (a low of 4.8 percent to a high of 65.6 percent). The weapons with the modified components consistently performed better than the standard production weapons. The performance reflected in Inclosure 6-2, Tables 24 and 25, can be directly compared with other tests of a similar nature (that is, with no adverse conditions) which involved the expenditure of 6,000 or 10,000 rounds.

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47 See Inclosure 6-2, Table 23, for detailed malfunction data.

THE FRANKFORD ARSENAL TEST OF PROPELLANTS

The Frankford Arsenal Test of Cartridge, 5.56mm, Ball, M193, Lots RA 5074 and WCC 6089 in Rifles, 5.56mm, XM16E1, and AR15, February 1966, had as its purpose "to determine the effect of propellant types on the functioning and reliability of 5.56mm XM16E1 rifles." The 12,000-round test was conducted under non-adverse conditions (bench rest firings) and the weapons cleaned and lubricated every 1,000 rounds.

The test report concluded:

> Cartridge lot WCC 6089 (Ball Propellant) gave a lower chamber pressure, a high port pressure, a higher cyclic rate, a greater malfunction rate, greater fouling, more variation in velocity due to variations in handling, and less bore erosion than did lot RA 5074 (IMR Propellant).

Four new XM16E1 rifles and two used AR15 rifles were tested. One XM16E1 and one AR15 rifle fired only ammunition loaded with IMR propellant; one XM16E1 and one AR15 rifle fired only ammunition loaded with ball propellant; and two XM16E1 rifles alternated between the two propellants every 3,000 rounds. Ammunition used was 5.56mm ball cartridge, Lots RA 5074 (IMR propellant) and WCC 6089 (ball propellant).

A summary of the reliability data contained in the test report is tabulated below:[48]

Rifle	Propellant	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
XM16E1	IMR	6,000	6	1.0
		10,000	17	1.7
		12,000	23	1.9
XM16E1	Ball	6,000	50	8.3
		10,000	115	11.5
		12,000	148	12.3
XM16E1	Mix	6,000	54	9.0
		10,000	154	15.4
		12,000	172	14.3
XM16E1	Mix	6,000	87	14.5
		10,000	123	12.3
		12,000	176	14.7
AR15	IMR	6,000	46	7.7
		10,000	71	7.1
		12,000	91	7.6
AR15	Ball	6,000	131	21.8
		10,000	177	17.7
		12,000	218	18.2
Total — all firings		72,000	828	11.5

The results of this test indicated clearly that there was a decided weapon-ammunition compatability problem, although Frankford Arsenal did not identify the cause or causes. The test report did point out that the stoppage rates per 1,000 rounds (as opposed to

[48] See Inclosure 6-2, Table 26, for complete malfunction data; Table 27 for malfunction data after the first 6,000 rounds; and Table 28 for the malfunction data after the first 10,000 rounds.

the malfunction rates indicated above) were 5.2 when ball propellant loaded ammunition was fired and .75 when IMR propellant loaded ammunition was fired. If only stoppages were considered, the rate using ball propellant loaded ammunition was still excessive. The malfunctions reported in this test are displayed in detail for 6,000, 10,000, and 12,000 rounds, as indicated above, so that comparisons can be made with the results of other tests when only 6,000 or 10,000 rounds were fired.

THE USATECOM ENGINEERING TEST

The USATECOM (D&PS) Engineering Test of Small Arms Weapons Systems (SAWS); Volume I, Partial Report, December 1965 (DPS-1851); and Volume I, Final Report, March 1966 (DPS-1970), stated its objectives:

> a. To determine the technical properties, performance, capabilities, and limitations of each of the candidate weapons and systems, in comparison with those of 5.56mm and 7.62mm small arms weapons currently in Army use in the ground and vehicular armament roles.
>
> b. To determine the degree to which the candidate weapons and weapons systems, and the standard weapons, fulfill requirements as expressed by the U.S. Army Combat Developments Command (USACDC).
>
> c. To provide the U.S. Army Ballistic Research Laboratories (USABRL) with appropriate data for use in parametric design studies to be conducted by USACDC.
>
> d. To provide, if appropriate, a basis for type classification action.

The SAWS rifles were tested against criteria established by USACDC in the following areas:

General characteristics, including accuracy, dispersion, safety, smoke and flash.

Adverse conditions, including unlubricated, high and low temperatures, temperature and humidity, water spray (rain test), salt water, sand, dust, and mud).

Reliability (6,000 round reliability test).

Sustained fire (continous fire at various sustained fire rates to determine weapon performance experienced in rapid or sustained firing).

Production model XM16E1 rifles with the old buffer and no chrome chamber and standard M14 and M14E2[49] rifles were used. The following lots were used:

AMMO	LOT NO.	PROPELLANT
5.56mm ball M193	RA 5089, RA 5090, RA 5122, RA 5123, RA 5134, WCC 6089	WC 846 ball
	RA 5072	CR 8136 IMR
5.56mm tracer XM196	RA 5019, RA 5031	WC 846 ball
7.62mm ball M80	RA 5374, LC 12424 WRA 22386	
7.62mm tracer	LC 12266	

49 The M14E2 rifle, formerly the Infantry Board M14, has a stock with a pistol grip and forehand grip, a bipod, and a modified muzzle break-flash hider.

The reliability data reported were as follows:[50]

Test	Weapon[a]	Rounds Fired	Malfunctions Total Number	Malfunctions Number per 1,000 Rounds
Miscellaneous: accuracy, smoke, and flash	XM16E1	3,319	78	23.5
	M14	7,625	11	1.4
Adverse Conditions: unlubricated, rain, dust, mud, sand, salt water	XM16E1	14,280	488	34.2
	M14	28,370	703	24.8
Reliability	XM16E1	32,975	1,173	35.6
	M14	70,344	211	3.0
Sustained fire	XM16E1	9,271	458	49.4
	M14	20,055	139	6.9
Total — all tests	XM16E1	59,845	2,197	36.7
	M14	146,394	1,064	7.3

[a] The M14 data includes all M14 and M14E2 firings.

The results of this test can be compared directly to other D&PS adverse conditions, reliability, and sustained fire tests previously conducted. The XM16E1 rifle malfunction rate was noticeably higher in this test than it was in previous tests of the same type. See Appendix 2 for a detailed analysis of this test.

[50] See Inclosure 6-2, Table 29, for detailed malfunction data.

THE USACDCEC FIELD EXPERIMENT

The USACDCEC Small Arms Weapons Systems (SAWS) Field Experiment, 10 May 1966, was conducted "to assist in the evaluation of designated candidate small arms weapons systems . . ." by:

1. Determination of the relative fire effectiveness of dismounted squads armed with various mixes of rifles, automatic rifles, and machine guns, including Soviet-type weapons.

2. Determination of the relative fire effectiveness of squads armed with standard U.S. 7.62mm weapons firing duplex ball ammunition, compared with squads firing ball ammunition.

3. Provision of certain data, such as firing scores, that might provide some insight into the relative ease or quality of training afforded by the different weapon systems, as a by product of the preparatory training phase of the experiment.

The reliability data were collected during preparatory training for the field experiments, experimental firings to check out range instrumentation, and during 1,007 record runs of nine tactical live-firing exercises on the experimental ranges. Although other weapons systems were in the experiment, only the reliability data for the M14 and XM16E1 are shown below.

The M14 and XM16E1 rifles used in the experiment were identical in configuration to those tested in the SAWS Engineering Test. The ammunition used in the test was:

AMMO	LOT NO.	PROPELLANT
5.56mm M193	WCC 6033, WCC 6098 WCC 6099, WCC 6102	WC 846 ball
	WCC 5074	CR 8136 IMR
5.56mm tracer M196		RA 223-117, RA 5019 RA 5020
7.62mm ball M80	RA 5374	
7.62mm M62	LC 12367	

The following reliability data were reported:[51]

			Malfunctions	
Phase	Weapon	Rounds Fired	Total Number	Number per 1,000 Rounds
Training	XM16E1	105,313	358	3.4
	M14	156,589	16	.1
Exploratory firing	XM16E1	66,822	457	6.8
	M14	47,889	22	.5
Field experiment	XM16E1	265,557	2,476	9.3
	M14	116,049	164	1.4
Total — all phases	XM16E1	437,692	3,291	7.5
	M14	320,527	202	.6
Special fouling test	XM16E1[a]	5,000	28	5.6
	XM16E1[b]	7,620	7	.9

[a] Fired with 5.56mm, M193, ball ammunition loaded with WC 846 propellant, Lot WCC 6098 (the same lot used in all phases of the field experiment), using six rifles.

[b] Fired with 5.56mm, M193, ball ammunition loaded with IMR (CR 8136) propellant, Lot RA 5074, using seven rifles.

The reliability data reported for this field experiment were collected by trained personnel under the supervision of USACDCEC. The

[51] See Inclosure 6-2, Table 30, for detailed malfunction data.

results, therefore, are considered valid and comparable with other evaluations conducted by USACDCEC, as well as with data reported by USATECOM (D&PS). The malfunction rates reported in the field experiment and the special fouling test clearly indicate a reliability problem with the XM16E1, as configured at that time, when firing ammunition loaded with WC 846 (ball) propellant.

THE SPRINGFIELD ARMORY BUFFER EVALUATION

The Springfield Armory Evaluation of Proposed Buffer Designs, 13 May 66, was a test to "evaluate buffers for the 5.56mm, XM16E1 rifle proposed by Colt's Industries." Functional tests were conducted with the standard buffer and four proposed buffers at various temperatures, using ammunition loaded with ball and IMR propellant. The conclusions of the evaluation were:

> The function with the proposed buffers and ball (WC 846) propellant was significantly better than the function with standard buffers and ball (WC 846) propellant.
>
> The performance when using the proposed buffers and ball propellant is not as good as the past performance of the M16 rifle using standard buffers and IMR (CR 8136) propellant.
>
> The function with the proposed buffers and IMR (CR 8136) propellant is not considered significantly changed from the function experienced in previous tests with standard buffers and IMR (CR 8136) propellant.
>
> The average cyclic rates of fire at -65°F with ball propellant and proposed buffers are within the range considered desirable for good weapon function.

At +155°F the average cyclic rates of fire with the proposed buffers and ball propellant were above the desired range but were significantly below the average obtained with ball propellant and standard buffers.

At ambient temperature the cyclic rates of fire with ball propellant and the proposed buffers were slightly higher than the cyclic rates with IMR propellant and standard buffers. The proposed buffers resulted in a significant rate reduction when compared to the standard buffers when the proposed and standard buffers were fired with ball (WC 846) propellant.

Six new XM16E1 rifles using 4 experimental buffer designs and the standard buffer were used for the evaluation. Ammunition used was:

AMMO	LOT NO.	PROPELLANT
5.56mm ball M193	RA 5175, RA 5176 WC 6089	WC 846 ball
	RA 5056, RA 5060 RA 5062	CR 8136 IMR
5.56mm tracer M196	RA 5019, RA 5031	RA 5025

The reliability data, using all buffer types, were reported as follows:[52]

			Malfunctions	
Ammo	Propellant	Rounds Fired	Total Number	Number per 1,000 Rounds
Ball	Ball (WC 846)	31,040	1,038	33.4
Ball	IMR (CR 8136)	25,520	141	5.5
Tracer	Ball (WC 846)	2,300	9	3.9
Tracer	IMR (CR 8136)	8,800	10	1.1

52 See Inclosure 6-2, Table 31, for detailed malfunction data.

This evaluation accomplished its objective in that it demonstrated that weapons with the standard buffer, firing ball propellant, experience high cyclic rates and correspondingly high malfunction rates, and that either of the new buffers which completed the entire test would lower both rates. The total malfunction rates shown in this test are not directly comparable to those in any other tests because of the various buffer assemblies used. The rates for the standard buffer and test buffer 2 (which was adopted as standard) can be compared with data from other tests.

THE USATECOM TEST OF PROPELLANTS

The USATECOM Engineer Design Test of Cartridge, 5.56mm, Ball, M193 (Evaluation of Improved and/or Alternate Propellants), 29 January - 19 May 1966, was conducted

> ... to ascertain the characteristics of two proposed alternate propellants in comparison with the standard ball propellant. Data on chamber and port pressure, velocity, action time, accuracy and dispersion, barrel erosion, propellant fouling, cyclic rate of fire, noise, smoke, and flash were recorded.

The firings were conducted under nonadverse conditions with rifles having the standard buffers and utilizing three propellant types. Each propellant was fired exclusively in two rifles, and all three propellants were fired in three rifles alternately. Nine production model XM16E1 rifles were used. Ammunition consisted of 5.56mm ball cartridge, M193, one lot (unnumbered) loaded with Dupont IMR 8208M propellant; one lot (unnumbered) loaded with Hercules IMR HPC 11 propellant; and one, Lot 223-163, loaded with WC 846 propellant.

The following reliability data were reported:[53]

Propellant	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
IMR 8208M	13,100	45	3.4
IMR HPC 11	13,100	241	18.4
WC 846	14,600	101	6.9
Mixed lots	5,020	45	8.9
Total	45,820	432	9.4

This test confirms the weapon systems sensitivity to the propellant and indicates that the IMR 8208M propellant was the most compatible with the system, equipped with the standard buffer, of any of the propellants tested. The reliability data reported in this test are directly comparable to those of other function tests conducted by USATECOM (D&PS).

THE USACDCIA TROOP ACCEPTABILITY TEST

The USACDC (CDCIA) Summary Report, SAWS Troop Acceptability Test, 3 June 1966, was intended "to develop implications of user acceptance of the candidate weapons systems available in hardware form, together with the impact each weapons system produces on training."

The test was conducted in five places: Fort Hood, Texas, the Federal Republic of Germany, Hawaii, Panama, and Alaska during the

53 See Inclosure 6-2, Table 32, for detailed malfunction data.

period October-December 1965. The reliability data contained in the report were collected during individual qualification firings and during squad and platoon unit firing exercises in the attack and defense, both day and night. The data presented deals with the XM16E1 used in the carbine, rifle, and automatic rifle roles, and all M14 and M14E2 firings in the rifle and automatic rifle roles.

The XM16E1, M14, and M14E2 rifles used in the test were of the same configuration as those used in the SAWS Engineering and Service tests previously discussed. Only the ammunition used in the Alaskan part was identified, and that consisted of:

AMMO	LOT NO.	PROPELLANT
5.56mm ball M193	FC 1810	WC 846 ball
5.56mm tracer M196	RA 5030	IMR (probably CP 8136)
7.62mm ball M80	FC 1926	
7.62mm ball M198(duplex)	FAP 7.62452	
7.62mm tracer M62	LC 12369	

The reliability data reported from the several test areas varied in detail. Although the primary purpose of this phase of the SAWS Study was not the collection of reliability data, the data reveal a lack of experience on the part of the test personnel at the various areas in the collection, analysis, and reporting of malfunctions. The data reported in this test are valid only in comparison of the reliability of the two weapons systems at a test cite where malfunctions were reported uniformly for both systems.

The reliability data contained in the report were as follows:[54]

Location	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
USARAL	XM16E1	32,522	21	.6
	M14	36,237	17	.5
USCONARC	XM16E1	22,726	463	20.4
	M14	54,291	112	2.1
USAREUR	XM16E1	61,608	22	.4
	M14	49,479	8	.2
USARPAL	XM16E1	83,598	17	.2
	M14	61,595	11	.2
USARSO	XM16E1	14,566	6	.4
	M14	11,012	7	.6
Total	XM16E1	215,020	529	2.5
	M14	212,614	155	.7

THE USAWECOM EVALUATION OF DRI-SLIDE

The USAWECOM Evaluation of Dri-Slide as a Lubricant for Small Arms Weapons, Technical Report 66-2397, August 1966, was made "To determine whether the properties and use of Dri-Slide as described and claimed by Dri-Slide, Inc. are valid," and "to determine whether Dri-Slide is inferior, equal, or superior to small arms lubricants

54 See Inclosure 6-2, Table 33, for detailed malfunction data.

authorized for use." The reliability data reported were obtained by firings at ambient temperatures, under dusty conditions, under sandy conditions, and at low temperatures (-50°F) with the test weapons in two conditions: dry, and lubricated only with the lubricants being tested

Standard issue M14 and M16 rifles were used but the ammunition was not identified.

The reliability data contained in the report are tabulated below:[55]

Test	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
Ambient	M16	400	0	.0
	M14	800	5	6.3
Dust	M16	300	2	6.7
	M14	600	3	5.0
Sand	M16	300	0	.0
	M14	713	55	77.1
-50°F	M16	100	1	10.0
	M14	200	0	.0
Total	M16	1,100	3	2.7
	M14	2,313	63	27.2

The data were obtained from very limited firings from only three weapons, one M16 and two M14's, under carefully controlled conditions: that is, the weapons were completely cleaned after

55 See Inclosure 6-2, Table 34, for detailed malfunction data.

each 100 rounds. These reliability data are not directly comparable to any other tests conducted on the two weapons systems, and are useful only in the comparison of the performance of the systems in this test.

SUMMARY

The results of the SAWS tests during this period reveal a sharp rise in the overall malfunction rate of the XM16E1. A summary of the test results is tabulated below.

Table 6-7 — SUMMARY OF SAWS STUDY CYCLE OF TESTS, 1965 - 1966

Test	Weapon	Rounds Fired	Malfunctions Total Number	Malfunctions Number per 1,000 Rounds
USATECOM January 1965	XM16E1	16,429	31	1.9
USATECOM March 1965	XM16E1 & M16	20,941	147	7.0
USATECOM[a/] December 1965	XM16E1	95,720	1,269	13.3
	M14	445,268	351	.8
Springfield Armory January 1966	XM16E1	328,000	4,524	13.8
Frankford Arsenal	XM16E1 &AR 15	72,000	828	11.5
USATECOM[b/] March 1966	XM16E1	59,845	2,197	36.7
	M14	146,394	1,064	7.3
USACDCEC[c/] May 1966	XM16E1	437,692	3,291	7.5
	M14	320,527	202	.6
Springfield[d/] Armory	XM16E1[e/]	33,340	1,047	31.4
	XM16E1[f/]	34,320	151	4.4
USATECOM[g/] May 1966	XM16E1	45,820	432	9.4
USACDC[h/] June 1966	XM16E1	215,020	529	2.5
	M14	212,614	155	.7
USAWECOM August 1966	M16	1,100	3	2.7
	M14	2,313	63	27.2
Total—all tests	XM16E1	1,360,227	14,449	10.6
	M14	1,127,116	1,835	1.6

a USAIB SAWS Service Test.
b D&PS SAWS Engineering Test.
c CDCEC SAWS Field Experiment.
d A test of proposed buffers.
e Firing cartridges loaded with WC846 (ball) propellant.
f Firing cartridges loaded with IMR (CR 8136) propellent.
g A test of alternate propellants (IMR 8208M, WC846, IMR HPC 11).
h CDCIA SAWS Troop Acceptability Test.

Further analysis of the malfunctions by type indicates that almost 64 percent of all malfunctions experienced in the 1,360,227 rounds fired were failures of the bolt to remain to the rear and failures to eject. The percentage of the total malfunctions experienced, by type, is shown below.

Table 6-8 — SUMMARY OF MALFUNCTIONS BY TYPE REPORTED IN THE SAWS STUDY, 1965 - 1966

		Malfunctions	
Type of Malfunction	Number	Percent of Total	Number per 1,000 Rounds
Failure to feed[a]	895	6.19	.66
Failure of bolt to remain to rear	4,734	32.76	3.48
Failure to eject	4,512	31.22	3.32
Failure to fire	1,236	8.55	.91
Failure to extract	392	2.71	.29
Bolt overrides the base of the round (a type of failure to feed)	1,020	7.0	.75
Double feed	439	3.03	.32
Broken part[b]	78	.53	.06
Failure of bolt to close[c]	159	1.10	.12
All others	984	6.91	.72
Total	14,449	100.00	

a Includes failure to feed first round.

b Includes defective part, inoperative part, and damaged part.

c Includes failure to strip round from magazine and failure to lock.

The following points are worthy of note:

The XM16E1 rifles used for the majority of firings during this period were equipped with the old buffer and did not have chrome chambers. Of the ammunition fired, by far the greater part contained WC 846 (ball) propellant. The durability of the XM16E1 was excellent. Only one-half of one percent of the malfunctions were attributed to broken, damaged, inoperative, or defective parts.

During late 1966, the first reports of jamming rifles were received from Vietnam. Because of the treatment given it by the public press, the reported jamming was associated with a failure to extract. In the language of the soldier, however, jamming also included failure to eject, failure to feed, failure to fire, bolt overriding the base of the round, and double feeding. Although the failure to extract was only 2.71 percent,or one in every 3,470 rounds fired, of all malfunctions experienced in the tests, the jamming, as far as the soldier was concerned, would happen about once every 160 rounds judging by test experience. In Vietnam, where cleaning material was lacking, maintenance knowledge and training were meager, and climate and terrain produced adverse conditions, jamming probably occurred more frequently.

New buffer designs for the XM16E1 had been submitted and partially tested in an effort to eliminate carrier bounce (and thus failure to fire caused by light strikes), and to reduce or eliminate malfunctions induced by high cyclic rate, bolt overriding the base of the round, failure of the bolt to remain to the rear, and, to some extent, failure to eject and failure to extract.

Consideration was also being given to chrome plating the chamber.

Tests Since the SAWS Study, 1967-1968

In the period following the Small Arms Weapons Systems Study, there have been seven tests which provided usable reliability data. These tests were conducted to determine the best lubricant for the M16A1 system and to examine proposed improvements.

THE USAF TEST OF CHROME CHAMBERS

The U.S. Air Force Marksmanship School Test of M16 Rifle Barrels with Chrome Chambers (Project 38-67), April 1967, was conducted to "Test six M16 chrome plated chamber barrels for suitability, for reduction of rusting problems, and for adverse functioning effects." The test under adverse conditions was specified:

> (1) Inundation in 5% salt solution at high heat level and high humidity, once at the beginning of the test (for 24 hours), and again for a longer period (for 48 hours) after 10,000 rounds have been fired.
>
> (2) Cold test one time with two weapons (1 test, 1 control) for 24 fours at 75 degrees below zero, and five weapons at this temperature.

All rifles were fired 200 rounds for barrel break-in before the adverse conditions tests were started. After exposure to adverse conditions, all rifles fired the first 2,000 rounds, without cleaning.

The test concluded that the test rifles with the chromed chambers performed much better than the standard rifles without the chromed chambers.

Ten standard M16 rifles were used, six of them refitted with chrome chambered barrels. No other modifications were made. The ammunition used was not identified.

The reliability of the M16's was reported as follows:[56/]

Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
M16 with chrome	65,780	133	2.0
M16 without chrome	46,080	184	4.0
Total	111,860	317	2.8

The results of this test indicated a significant reduction in double feeding, failure to feed, and failure to extract in the rifles with the chrome plated chambers when they were tested under adverse conditions. However, the test also indicated an increase in parts attrition and failures to eject. The results of this test are not directly comparable to any other tests conducted.

THE ARCTIC TEST OF LUBRICANTS

The U.S. Army Arctic Test Center Engineer Design Test of Preservative Lubricants for Small Arms Weapons under Arctic Winter and Spring "Break Up" Conditions, 25 May 1967, was conducted to

56 See Inclosure 6-2, Table 35, for detailed malfunction data.

"determine the suitability of the test lubricants when applied to small arms weapons that are continuously exposed to and fired under Arctic winter and spring break-up conditions. . . ." The conclusions of the test were that the experimental lubricants A and B (modifications of MIL-L-46000A) were best suited for use on small arms in that environment. The reliability data were collected during both automatic and semiautomatic firings under varying conditions of exposure to low temperatures (-1° to -59°F) and blowing snow, and during several consecutive days of firing without cleaning or lubricating.

Ten standard M16A1 rifles with the new buffers and ten M14 rifles were used in the test. The ammunition was not identified.

The reliability data that were collected reported only "those stoppages attributable to poor lubrication" and the number of parts that were replaced on the weapons. The data are tabulated by kind of lubricant and totaled by the type of rifle.[57]

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57 See Inclosure 6-2, Table 36, for detailed malfunction data.

Lubricant[a]	Weapon	Rounds Fired	Malfunctions Total Number	Malfunctions Number per 1,000 Rounds
LAW	M16A1	17,110	180	10.5
	M14	16,813	44	2.6
LSA	M16A1	17,000	139	8.6
	M14	17,280	28	1.6
A	M16A1	16,871	80	4.7
	M14	16,992	31	1.8
B	M16A1	17,280	116	6.7
	M14	16,257	39	2.4
S/F	M16A1	15,600	60	3.8
	M14	15,600	282	18.1
Total-- all tests	M16A1	83,861	575	6.9
	M14	82,942	424	5.1

[a] Lubricant types: LAW = MIL-L-14107, a standard Arctic weapons lubricant; LSA = MIL-L-46000A, a semifluid, synthetic base, preservative lubricating oil (found best for use on the M16A1 above 0°F — see USAWECOM test of lubricants, June 1967); A = an experimental lubricant similar to LSA with the thickener omitted; B = an experimental lubricant similar to LSA with the synthetic base fluid changed; S/F = MIL-L-46010A a resinbonded, heat-cured, solid film lubricant.

If all malfunctions had been reported, the malfunction rates of both weapons would have been higher. It should be noted that the 74.3 percent of the reported malfunctions of the M16A1 were failures to feed, a malfunction which can often be attributed to the magazine. Of the total M14 malfunctions 65 percent were attributable to the failure of the bolt to close (includes failure to chamber and failure to lock; of that 65 percent, 40.5 percent were experienced with two rifles in one subtest with one lubricant (3 days firing - S/F lubricant). The test is considered a valid comparison of weapons performance under Arctic conditions.

THE USATECOM TEST OF LUBRICANTS

The USATECOM Military Potential Test of Weapons Lubricant, Technical Report 67-1380, June 1967 was conducted: "To investigate four lubricants (Dri-Slide, VV-L-800, NRL 4002-36, and MIL-L-46000A) on the M16A1 (XM16E1) rifle with regard to weapon functioning performance and corrosion resistance." In comparing the relative merits of the lubricants, the rifles were subjected to standard adverse conditions tests (saltwater immersion, dust, mud, sand-drag, water spring (rain)) as well as a reliability test and a dynamic dust test. The test report concluded that MIL-L-46000A, a standard automatic weapons lubricant, was superior to the other lubricants tested for use with the M16A1 rifle above 0°F.

One hundred and twenty-two production model M16A1 rifles with the redesigned buffer were used in the test. 12 M14 rifles were fired only in the dynamic dust test; no data is shown for them. No ammunition was identified.

The following reliability data were reported:[58]

Test	Lubricant	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
Adverse conditions	Dri-Slide	14,874	793	53.3
	VV-L-800	15,219	829	54.5
	NRL	15,068	335	22.2
	MIL-L-46000A	16,832	339	20.1
Total		61,993	2,296	37.0
Reliability	Dri-Slide	50,260	2,007	39.9
	VV-L-800	50,300	1,611	32.0
	NRL	47,200	857	18.2
	MIL-L-46000A	51,000	494	9.7
Total		198,670	4,969	25.0
Total — all firings		294,355	7,281	24.7

The results of this test are directly comparable with previous adverse conditions and reliability tests conducted by the Development and Proof Services. Of the total malfunctions experienced in the adverse conditions tests, 78.1 percent were attributable to two types of malfunctions: failure to feed, 41.1 percent, and failure of the trigger to return, 37.0 percent. Failure to feed is usually caused by the magazine, while the failure of the trigger to return is normally a dimensions and clearance problem, and should be largely controlled or eliminated by quality assurance inspections. In the reliability tests, failures to feed accounted for 53.9 percent

58 See Inclosure 6-2, Table 37, for detailed malfunction data.

of the malfunctions, and failure of the trigger to return for 33.4 percent. Since the experience rate of failures of the trigger to return was about equal in both tests, weakness in quality assurance inspections or perhaps a design deficiency is suspected. This type of malfunction is expected to occur in tests under adverse conditions of dust, mud, and sand much more frequently than in the reliability tests.

THE USATECOM MAGAZINE TEST

The USATECOM (D&PS) Final Report on the Engineering Design Test of the 20-Round, Disposable Magazine, for the M16A1 Rifle, October 1967, actually covered two engineer design tests.

> The objective of the first EDT was to provide a basis for low-risk selection of one or more designs which would then be subjected to a second EDT after all necessary design improvements were made. The objective of the second EDT was to directly compare the durability and reliability of the test magazines with that of the standard 20-round metallic magazine for purposes of selection and limited-production procurement of a disposable type magazine if proven suitable.
>
> The aggregate goal of this program is the determiniation of overall comparability of the disposable and standard magazines which included durability, reliability, and cost. This report evaluates the technical aspects only; the cost factor is not considered.

The reliability data were collected during firings under adverse conditions (dust, sand, mud, water immersion, high temperature, low temperature, and heat and humidity) and firings for function and durability. The data presented here were collected only during the second EDT, since the first EDT was conducted to eliminate all but the most promising designs of the prototype magazines.

Standard M16A1 rifles with the new buffer and 5.56mm ball cartridge M193, Lots LC 12124 and RA 5101 were used in the tests. The propellants were not specified.

The following malfunctions were reported:[59]

Test	Magazine[a]	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
Adverse conditions	1-A	5,793	89	15.4
	5-B	3,632	188	51.8
	Standard	5,569	130	23.3
Function and durability	1-A	2,400	17	7.1
	5-B	2,400	31	12.9
	Standard	2,399	16	6.7
Totals	1-A	8,193	106	12.9
	5-B	6,032	219	36.3
	Standard	7,968	146	18.3

[a] Test magazine 1-A was designed by Limited War Laboratory; magazine 5-B was designed by Rock Island Arsenal; the standard magazine is the 20-round aluminum magazine currently issued.

The actual malfunction rates experienced were higher than those indicated above because "The malfunctions and defects tabulated in (the) report are those chargeable against the test magazine." The

59 See Inclosure 6-2, Table 38, for detailed malfunction data.

majority of the malfunctions reported for all magazines was in the category of failure of the bolt to remain to the rear: 1-A, 57.? percent; 5-B 64.4 percent; and standard, 52.7 percent. The remaining malfunctions reported for all magazines were failures to feed of various types (BOB, DF, FF, FF-1, and SR).

THE USACDCEC IRUS TEST-PHASE I

The USACDCEC Report on the Reliability of the M16A1 Rifle During Phase I of IRUS 70-75 Field Experimentation, 3 November 1967 was another test report that furnished usable data. In the words of the report:

> IRUS 70-75 was designed to provide data that would assist in the determination of the doctrine of the employment and detailed organization of U.S. Army small infantry units during the 1967 to 1975 time period. Collection of weapons reliability data was incidental to the main purpose of the experiment.

The reliability data were collected during live firing, tactical attack and defense exercises, both day and night, using infantry units of varying sizes.

New production model M16A1 rifles with new buffers were used in the experiment. The following lots of 5.56mm ball, M193, ammunition loaded with WC 846 (ball) propellant were used:

FC 1829	FC 1831	FC 1836	RA 5187
FC 1830	FC 1832	RA 5123	RA 5189

Only one lot of 5.56mm tracer, M196 — RA 5019 loaded with IMR 4475 propellant — was used.

The reliability data were reported as follows:[60]

Firing Program	Rounds Fired	Malfunctions Total Number	Malfunctions Number per 1,000 Rounds
4 to 9-Man program	300,335	384	1.27
5-Man program	118,192	173	1.46
Special program	90,385	141	1.56
Total	508,912	698	1.37

As indicated above, the primary purpose of the experimentation was not the collection of weapons reliability data, and therefore, some malfunctions probably escaped detection and reporting. The results of this experiment indicated a high percentage of failure to extract malfunctions, 27.4 percent of the total. The most frequent malfunction experienced was double feed, 35.7 percent of the total, which can be attributed primarily to the magazines. The 30-round, nonstandard, magazines were originally procured in 1965 for use in the SAWS field experimentation, and had been used continually since that time. Another 15.5 percent of the malfunctions were of the failure to feed type (BOB, BUB, and FF) which can also be partly attributed to magazines.

THE APG TEST OF CHROME CHAMBERS

The Aberdeen Proving Ground "Letter Report of the Initial Production Test of Chrome Plated Chambers for M16A1 Rifles," 20 December 1967, provided usable data. Its purpose was "to determine

60 For detailed malfunction data, see Inclosure 6-2, Table 39.

the relative performance levels of chrome plated and non-plated chambers when subjected to selected adverse conditions and extended firings under temperatures of $60^{o} \pm 10^{o}F$." The selected adverse conditions included static dust, dynamic dust, saltwater immersion, and high temperature and humidity tests. A 10,000-round function and durability test was also conducted, using three chrome chambered rifles.

Production model M16A1 rifles, five with chrome plated chambers and two without, were used; all weapons had the new buffer. All firing was conducted with M193 ball cartridges loaded with WC 846 (ball) propellant. The lot numbers were not identified.

The following reliability data were reported:[61]

Test	Rifle Configuration	Rounds Fired	Malfunctions Total Number	Malfunctions Number per 1,000 Rounds
Static dust	w/chrome	1,000	34	34.0
	w/o chrome	1,000	41	41.0
Dynamic dust	w/chrome	3,640	53	14.6
	w/o chrome	3,423	62	18.1
Saltwater immersion[a]	w/chrome	360	0	.0
Heat and humidity	w/o chrome	360	2	5.6
Total adverse conditions	w/chrome	5,000	87	17.4
	w/o chrome	4,783	105	22.0
Function and durability	w/chrome	30,000	59	1.96

[a] Failures to extract were the only malfunctions to be reported.

61 For detailed malfunction data see Inclosure 6-2, Table 40.

Of the 59 malfunctions reported in the function and durability test, 29 or 49.2 percent were failure of the bolt to remain to the rear, and 15 or 25.4 percent were failure of the bolt to close. There were no failures-to-extract malfunctions experienced in firing 30,000 rounds in three chrome chambered rifles during the function and durability test.

THE USA TECOM BUFFER TEST

The USATECOM (D&PS) Final Report on Product Improvement Test of Redesigned Buffer for M16A1 Rifles (DPS-2662), January 1968, had as its objectives:

a. To compare cyclic rates of fire using the old and new buffers.

b. To compare bolt rebound upon closing, using the old and new buffers.

c. To permit a comprehensive evaluation of the old and new buffers in the M16A1 rifle.

The reliability data were collected during firings for cyclic rate, adverse conditions (including high humidity, high temperature, low temperature, dynamic dust, and saltwater immersion), fouling, extreme attitude functioning, and accelerated rate.

Standard production model M16A1 rifles were used, alternating the old and new buffers in the weapons and firing with ball and tracer ammunition loaded with both IMR (CR 8136) and ball (WC 846) propellants. The ammunition used in the tests was:[62]

M193, ball, Lot LC12177 (WC846, ball, propellant)
M193, ball, Lot TW18166 (CR8136, IMR, propellant)

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[62] Three M16A1 rifles were fired in a special firing test using ball and tracer ammunition loaded with both WC 846 (ball) and 8208M (IMR) propellant. That data is not included in this summary.

M196, tracer, Lot LC12081 (WC846, ball, propellant)
M196, tracer, Lot TW18001 (CR8136, IMR, propellant)

The reliability data reported are tabulated below:[63]

Test	Buffer	Ammo	Propel	Rounds Fired	Malfunctions Total Number	Malfunctions Number per 1,000 Rounds
All except saltwater immersion	Standard	Ball	IMR	12,470	818	14.5
		Ball	Ball	12,470	271	21.7
		Tr	IMR	12,365	226	18.3
		Tr	Ball	12,365	240	19.4
	Redesigned	Ball	IMR	12,470	226	18.1
		Ball	Ball	12,470	57	4.6
		Tr	IMR	12,365	188	15.2
		Tr	Ball	12,365	227	18.4
Saltwater immersion	Redesigned	Ball	IMR	900	35	38.9
		Ball	Ball	900	57	63.3
		Tr	IMR	900	46	51.1
		Tr	Ball	900	23	25.6

The results of this test indicate that the new or redesigned buffer, firing the optimum ammunition mix of ball propellant with ball projectiles and IMR propellant with tracer projectiles in a 4 to 1 ratio, achieves approximately a 45 percent reduction in total malfunctions over the old or standard buffer, firing its optimum ammunition mix of IMR propellant in both ball and tracer cartridges in a 4 to 1 ratio.

The most significant reduction was achieved by the redesigned buffer in failures to feed (FF, BOB, FF-1, DF) malfunctions. Reductions in failures to extract and eject were also evident, but not in significant numbers. The results further indicate that the

63 For detailed malfunction data, see Inclosure 6-2, Table 41.

current ammunition loading restrictions of only IMR propellant in tracer and only ball propellant in ball ammunition will provide the best operational reliability for the M16A1 in its current configuration.

SUMMARY

The results of the tests conducted since the SAWS Study during 1967 - 1968 indicated a significant decrease from 10.6 during the 1965-66 period to 3.9 in the overall M16A1 malfunction rate. A summary of the test results is shown in Table 6-9.

Table 6-9 — SUMMARY OF TEST RESULTS, 1967-1968

Test	Weapon	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
USAF April 1967	M16A1	111,860	317	2.8
USA Arctic Test Ctr[a] May 1967	M16A1	83,861	575	6.9
	M14	82,942	424	5.1
USATECOM[b] June 1967	M16A1	67,832	833	12.3
USATECOM[c] October 1967	M16A1	7,968	146	18.3
USACDCEC[d] November 1967	M16A1	508,912	698	1.4
USATECOM[e] December 1967	M16A1	35,000	146	4.2
USATECOM[f] January 1968	M16A1	49,660	698	14.1
Total — all tests	M16A1	865,093	3,413	3.9
	M14	82,942	424	5.1

[a] Arctic lubricants test, data includes performance under adverse Arctic conditions using all test lubricants.

[b] Lubricants test, data is only for malfunctions occurring while LSA (MIL-L-46000A) lubricant was used.

[c] Magazine test, data is only for malfunctions occurring while standard 20-round magazine was used.

[d] Field experiment, field firings similar to SAWS, using the M16A1 with the new buffer (no chrome chamber).

[e] Chrome chamber test, data is only for malfunctions occurring while chrome plated chambers were used.

[f] Buffer test, data is only for malfunctions occurring while the new buffer was used.

Analysis of the malfunctions by type indicates that various types of failure to feed malfunction (FF, FF-1, DF, BOB, FBC, and BOB) accounted for 60.68 percent of a.l malfunctions in firing 865,093 rounds. The percentage of tctal malfunctions experienced, by type, is shown in Table 6-10.

Table 6-10 — SUMMARY of MALFUNCTIONS BY TYPE, 1967 - 1968

Type of Malfunction	Number	Percentage of Total Malfunctions	Occurrence per 1,000 Rounds
Failure to feed[a]	1,464	42.89	1.69
Failure of bolt to remain to rear	135	3.96	.16
Failure to eject	182	5.33	.21
Failure to fire	131	3.84	.15
Failure to extract	338	9.90	.39
Bolt Overrides the base of the round[b]	212	6.21	.25
Double feed	264	7.74	.31
Broken part[c]	130	3.81	.15
Failure of bolt to close[d]	131	3.84	.15
All other malfunctions	426	12.48	.49
Totals	3,413	100.00	

a Includes failure to feed first round.

b Includes bolt underrode the base of the round

c Includes defective part, inoperative part, and damaged part.

d Includes failure to strip round from magazine and failure to lock.

The following changes in malfunction rates from those experienced during the 1965-1966 period are worthy of note:

There was a significant increase in the rate of failure to feed malfunctions from .66 per 1,000 rounds to 1.69.

There was a significant reduction in the malfunction rate of failure of the bolt to remain to the rear — from 3.48 per 1,000 rounds to .16; failure to eject — from 3.32 per 1,000 rounds to .21; and failure to fire — from .91 per 1,000 rounds to .15.

Incidents of failure to extract increased slightly, from .29 per 1,000 rounds to .39.

On the whole the M16 rifle system showed improved reliability with the adoption of LSA lubricant, the new buffer, and the chrome plated chamber.

Vietnam Reports on the Reliability of the M16A1 Rifle, 1967 - 1968

The M16A1 (XM16E1) rifle was introduced in significant numbers into Vietnam with the first U.S. Army ground combat units (173d Airborne Brigade and 1st Brigade, 101st Airborne Division) which were deployed there in the spring and summer of 1965. During the rest of 1965, there were no reports to Headquarters, Department of the Army, that the troops were having problems with the reliability of the rifle. There were two principal reasons for the early lack of complaints. First, the units that had the weapon were well-trained in its use and maintenance.[64] The airborne units, for example, were issued the XM16E1 a year or more before they went to

64 See Appendix 3 for information on training.

Vietnam, and had the necessary cleaning materials on hand when they arrived. Second, the troops were not engaged in extensive operations during their first months in Vietnam and therefore had more time for maintenance.

In late 1965, COMUSMACV requested that all U.S. maneuver units be equipped with the XM16E1 rifle.[65] All available weapons were shipped within a few weeks, and additional procurement was initiated.[66]

The first indication of problems with XM16E1 reliability was contained in a message from U.S. Army, Vietnam, requesting priority airlift of cleaning rods, and voicing an urgent need for a chamber cleaning brush. The message stated in part:

> In light of recent reports from the field of malfunctions attributable to lack of cleaning equipment necessary to remove carbon which accumulates in the chamber, an urgent requirement exists for the chamber brush. . . .[67]

During the spring and summer of 1966 XM16E1 rifles were issued to other USARV units as fast as they were produced. Because of the increase in the number of rifles and the increased combat activity of the

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65 USARV Msg 42787, 6 Dec 65.

66 See Appendix 5 for procurement and distribution.

67 USARV Msg, AVD-MD 03087, 8 Feb 66, to CG USAWECOM.

U.S. units, the USARV supply of cleaning materials evidently became critical, for in September 1966 the 1st Logistical Command requested the airlifting of 50,000 cleaning rods and 50,000 bore brushes as soon as possible.68/

In October 1966, the problems with the XM16E1 had become serious enough to prompt USARV to initiate training, maintenance, and inspection programs in Vietnam and to request a technical assistance team from USAWECOM. Further, the technical team was requested to bring a supply of repair parts with it.69/ The team was dispatched immediately. On 30 October 1966, the team chief forwarded an informal report to the Project Manager, Rifles, confirming the existence of the problems previously reported in training, maintenance, and the availability of cleaning materials and spare parts.70/ Although no statistics were developed in Vietnam on the reliability of the rifle during late 1965 and 1966, it was quite evident that a significant number of malfunctions were occurring. The most significant, the most difficult to clear, and the one that received the most publicity was failure to extract.

The maintenance assistance and instruction given to almost every major Army unit in Vietnam by the technical assistance team, and the resulting improvement in maintenance, together with the provision of more

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68 1st Log Comd Msg AVCA GL-M 09660, 26 Sep 66, to CG USAWECOM.
69 USARV Msg, AVHGD-MD 29518, 11 Oct 66, to CINCUSARPAC.
70 Team Chief to The Project Manager, Rifles, 30 Oct 66.

maintenance materials and the introduction of the new buffer, significantly improved the reliability of the M16A1 in the Army units during the period January - June 1967.

During the spring of 1967, the U.S. Marine Corps issued the XM16E1 rifle to its combat units in Vietnam. The Marine Corps was soon plagued with the same reliability problem, primarily because of inadequate training in the maintenance of the weapon and an insufficient resupply of maintenance materials, particularly cleaning rods and chamber brushes. The commander of III Marine Amphibious Force had been offered the use of the USAWECOM technical assistance team on 22 November 1966 by the Project Manager, Rifles, but had refused the offer.[71]

The technical assistance team returned to the continental United States in late November 1966, but was again dispatched to Vietnam early in 1967 to follow up on training in the maintenance of the rifle. The team found that the maintenance of the weapon and its reliability had improved considerably, although the failure to extract malfunction continued to be a problem. During this trip, the team chief recommended that consideration be given to chrome plating the chamber of the M16A1 rifle to preclude rust, inhibit corrosion and pitting, and facilitate cleaning. The recommendation was adopted, and beginning in September 1967, all rifles and all replacement barrels were produced with chrome plated chambers.

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71 Statement by The Project Manager, Rifles, ORDC, 8 Jan 68.

The only detailed malfunction data reported from Vietnam has been collected by the III Amphibious Force. Beginning in June 1967, the III Amphibious Force initiated a biweekly malfunction report on the M16A1 rifle. Although many of the malfunctions occurring were probably not reported because of the difficulty in assembling such information in combat, it is the only data available.[72]

Table 6-11 — U.S. MARINE CORPS M16A1 MALFUNCTIONS IN VIETNAM

			Malfunctions	
Time Period	Number of M16A1's	Number Rounds	Total Number	Number per 1,000 Rounds
13-30 Jun 67	23,600	Unknown	803	—
1-13 Jul 67	23,600	Unknown	132	—
14 Jul - 10 Aug 67	23,600	Unknown	272	—
19-30 Nov 67	40,157	2,132,752	2,653	1.243
1-15 Dec 67	43,177	1,551,369	3,629	2.339
16-31 Dec 67	41,806[a]	1,507,612	1,514	1.004
	3,795[a]	39,750	22	.553
1-15 Jan 68	41,039[a]	1,350,765	1,088	.805
	3,838[b]	84,600	45	.532
16-30 Jan 68	39,416[a]	1,498,511	834	.556
	3,959[b]	37,800	6	.159
1-15 Feb 68	40,398[a]	1,430,126	833	.582
	3,399[b]	48,100	5	.104
Total	w/o chrome	9,471,135	10,551	1.114
(19 Nov 67 - 15 Feb 68)	w/ chrome	210,250	78	.371

[a] M16A1's without chrome plated chamber, but with new buffer.

[b] M16A1's with both the chrome plated chamber and the new buffer.

[72] For detailed malfunction data, see Inclosure 6-2, Table 42.

Since 19 November 1967 the Marine Corps has been reporting only five types of malfunctions — failure to feed, failure to fire, failure to eject, failure to extract, and ruptured cartridges because of the difficulty of collecting information from units in combat. The malfunction rates shown in Table 6-11, therefore, are lower than the actual rates experienced. The percentage of total malfunctions reported, by type, and the occurrence per 1,000 rounds are indicated in Table 6-12. Only the occurrence per 1,000 rounds is comparable to other data previously presented.

Table 6-12 — VIETNAM REPORTED MALFUNCTIONS BY TYPE

Type of Malfunction	Number	Percentage of Total[a] Malfunctions	Occurrence per 1,000 Rounds
Failure to feed	2,938	27.64	.303
Failure to eject	1,249	11.75	.129
Failure to fire	636	5.99	.066
Failure to extract	5,570	52.40	.575
Ruptured cartridge[b]	236	2.22	.024
Totals	10,629	100.00	

[a] The percentage indicated is that of total malfunctions reported as opposed to total malfunctions experienced.

[b] Ruptured cartridge as reported by the III Marine Amphibious Force is not the circumferential rupture described in Inclosure 1, but a rupture of the cartridge case at the base, usually resulting in an expanded receiver (or a blow-up) of the weapon. This malfunction is almost always due to an obstruction in the bore (a bullet, a section of cleaning rod, sand, water, mud, or other foreign substance).

With the exception of failures to extract, the occurrence rate per 1,000 rounds, for all malfunctions reported, is lower than that experienced in testing.

The Panama Test, January 1968

The most recent, and probably most valid reliability test of the M16A1 weapon system in the hands of troops, was conducted in Panama by the U.S. Marine Corps under the direction of the Weapons Systems Evaluation Group (WSEG), Office of the Secretary of Defense.

This test was initiated as a result of a recommandation contained in the House Armed Services Committee Special Subcommittee on the M16 Rifle Program Report of 19 October 1967.

In response to Chairman Ichord's recommendation:

> that the Department of Defense direct and expedite a thorough and objective test by an independent organization of the weapon system consisting of the modified rifle and the ammunition in Vietnam, as well as both types of propellant currently being loaded in 5.56mm ammunition.73/

the Director of Defense Research and Engineering (DDRE), on 20 November 1967, designated WSEG as the executive agent for conducting an operational reliability test of M16A1 rifle system. WSEG's responsibilities included establishing test conditions and procedures, monitoring the test, reducing test data, evaluating test findings, and preparing the final report.74/

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73 Page 5370, Rpt of the Special Subcommittee on the M16 Rifle Program, House Armed Services Committee, 19 Oct 67, p. 5370.

74 DDRE Memo, 20 Nov 67, sub: Simulated Combat Test of the M16 Rifle System.

The DDRE memorandum assigned the U.S. Marine Corps responsibility for execution of the test and for obtaining weapons, ammunition, other materiel, and personnel. The Department of the Army was directed to furnish materiel, test facilities, and other assistance. The M16A1 rifle system test plan, published by WSEG on 29 December 1967, provided for conducting the test in the Canal Zone, Panama, during the period 6-26 January 1968.

Objectives of the test were:

1. Using 5.56mm ammunition of the types now used in Vietnam, that is, loaded with both ball (WC 846) and IMR propellants

Determine the malfunction rates of the M16A1 rifle configured with the new buffer assembly and chromed chamber;

and determine the malfunction rates of the M16A1 rifle configured with the new buffer assembly.

2. Determine the malfunction rate of the M14 rifle system.

3. Analyze and compare the preceding malfunction rates.

4. Identify for each rifle system and configuration the types of malfunctions that occur and the environment and conditions under which they occur.

Data were obtained by controlled field testing in the Canal Zone, Panama, during the period 9-25 January 1968. To provide weapon exposure similar to that of Vietnam, four separate environmental areas were used representing (1) saltwater and sand, (2) muddy water and swamp, (3) rain forest, and (4) dust, and simulated uplands. Four fifty-six man platoons of Marine riflemen conducted realistic combat maneuvers and rifle firing for three consecutive days in each area, rotating through all four environments.

The main test employed three types of rifles: 96 M16A1's with the new buffer and chromed chamber; 96 M16A1's with the new buffer but no chromed chamber, and a control group of 96 M14 rifles. All were selected at random, the M16A1's from new, and the M14's from reconditioned stocks. One half of each type of M16A1 rifles fired ammunition loaded with ball (WC 846) propellant throughout the test; the remaining half fired ammunition loaded with IMR 8208M propellant. The M14's fired ammunition with ball propellant. Firing modes were controlled with one half automatic, the other semiautomatic. One-half the magazines were loaded to the 20-round capacity, the other half to 18 rounds. Two cleaning schedules were followed for the main test, each applicable to one-half the rifles by type, and for the M16A1, further applicable to one-half, by type of propellant. One schedule directed cleaning at noon each day after firing 240 rounds and again at night after an additional 240 rounds had been fired. The other specified cleaning only at noon each day after a total of 480 rounds had been fired. Loaded magazines were carried by the riflemen and exposed to the same environmental conditions as the rifles; however, the magazines were cleaned and loaded by a special ammunition detail throughout the test to insure positive control of ammunition types. It is believed that failure to feed malfunctions would have been more frequent if the riflemen had been required to maintain and load their own magazines.

Principal Findings. The malfunction results from the WSEG tests are tabulated below. The operational reliability of the M16A1 with IMR 8208M propellant was found to be significantly less than with ball (WC 846) propellant.[75]

M16A1 Malfunctions

Weapon Configuration	Propellant: Ball	IMR	Ball and IMR Combined
Chrome chamber	582	1,198	1,780
Unchromed chamber	482	1,419	1,901
Total	1,064	2,617	3,681
Rounds fired	544,271	543,864	1,088,135

M16A1 Malfunction Rates per 1,000 Rounds Fired

Weapon Configuration	Propellant: Ball	IMR	Ball and IMR Combined
Chrome chamber	2.14	4.40	3.27
Unchromed chamber	1.77	5.22	3.49
Total	1.95	4.81	3.38

As a means of comparison, the M16A1 with WC 846 ball propellant experienced 1.95 malfunctions per 1,000 rounds fired, whereas the control M14 rifles experienced 1.40 malfunctions per 1,000 rounds. The report found this difference to be significant.

75 "Significantly" is used here and elsewhere in this section in the statistical sense. Results are "significantly" different if the likelihood, or probability of their being obtained by chance is very small - usually five or fewer chances out of a hundred.

The differences in M16A1 operations reliability among weapons firing ball propellant and those firing IMR were significantly smaller in the second half of the test than they were in the first half due to a reported change in cleaning emphasis.

Test personnel were required to clean the firing pin well in the bolt to reduce or eliminate failures to fire caused by carbon buildup which restricted movement of the firing pin and induced light blows on the primer.

Weapon Configuration	Malfunction Rates per 1,000 Rounds Fired			
	First Half of WSEG Test		Second Half of WSEG Test	
	Ball	IMR	Ball	IMR
Chrome chamber	2.29	5.25	1.99	3.56
Unchromed chamber	1.57	7.54	1.97	3.90

For both types of propellant, the operational reliability differences between chromed and unchromed chambers were statistically significant in the first 12 of the 24 firing periods, and not significant in the second 12 periods. Possible reasons for this phenomenon are not presented in the report.

As a function of exposure in beach, swamp, rain forest, and upland environments, the operational reliability of the M16A1 using IMR 8208M propellant is characterized by large fluctuations within and between environments. The M14 showed the least fluctuation, followed closely by the M16A1 using ball propellant. The fluctuation among environments is tabulated below.

	Malfunction Rate per 1,000 Rounds Fired		
	M16A1		
Environment	Ball	IMR	M14
Beach	3.00	8.37	1.93
Swamp	1.64	4.59	1.10
Rain forest	1.40	2.98	1.10
Uplands	1.78	3.32	1.47

A downward time trend in M16A1 malfunctions using IMR propellant was observed, and major fluctuations within a given environment could usually be associated with unusual environmental conditions, such as high seas and wind at the beach site.

For all rifle systems under test, the malfunction rates experienced in the automatic fire mode were significantly higher than those experienced in the semiautomatic mode. The following data are relevant:

	Malfunction Rate per 1,000 Rounds Fired		
	M16A1		
Firing Mode	Ball	IMR	Tracer
Automatic	2.11	6.45	1.67
Semiautomatic	1.79	3.04	1.11

As of 15 March 1968, the detailed WSEG data were not available to the Army for further determination of any significant correlation of operational reliability between modes for fire, on the one hand, and chrome or unchromed chambers, on the other.

The WSEG report comments on the two major recent improvements to the M16A1 system, the new buffer and chromed chamber, but does not address other rifle modifications.

All M16A1's were equipped with the new buffer; therefore, no comparison with the original buffer can be made. No difference was found in the functioning of rifles factory-equipped with the new buffer and those fitted in the field.[76]

In the test, 96 M16A1's had chrome plated chambers and 96 did not. The comparative malfunction results were mixed and are not clearly understood at this time. Chrome chambered M16A1's firing ball propellant had significantly more total malfunctions than those with the unchromed chambers. Chrome chambered M16A1's firing IMR propellant had significantly fewer total malfunctions than those with the unchromed chambers.

Two advantages of the chrome chamber were statistically significant. First, the M16A1's without chromed chambers had more malfunctions when cleaned after alternative firing periods than when cleaned after each firing period. On the other hand, the malfunction rate of chrome chambered M16A1's was the same for both cleaning schedules. Second, failures to extract were twice as frequent in M16A1's with unchromed chambers as in M16A1's with chromed chambers.

[76] This result, contained in the published WSEG report, has subsequently been modified orally by statements to the effect that there was a significant difference. As of 15 March 1968, detailed data was not available to the Army for the purpose of verifying this conclusion.

The test results provide information on the relative frequency and severity of various malfunctions; however, engineering analysis is required to determine the cause of and correction for these malfunctions. The following are especially significant:

Total M16A1 malfunctions, by type, for both ball and IMR propellants were as shown below. Approximately 544,000 rounds were fired with each propellant.

Type of Malfunction	Number of Malfunctions Ball	IMR	Total	Occurrence per 1,000 Rounds
Failure to feed	150	1641	1791	1.65
Failure to chamber	91	360	451	.41
Failure of bolt to remain at rear after last round	49	344	393	.36
Failure to eject	280	15	295	.27
Failure to fire	184	82	266	.24
Failure to extract	125	53	178	.16
All others	185	122	307	.28
Total	1,064	2,617	3,681	

Of those M16 malfunctions indicated above requiring armorer assistance to clear, the occurrence by type was:

Type of Malfunction	Number of Malfunctions Ball	IMR	Total	Occurrence per 1,000 Rounds
Failure to feed	1	22	23	.021
Failure to eject	20	0	20	.018
Failure to fire	10	6	18	.015
Failure to extract	7	3	10	.010
Failure to chamber	3	5	8	.007
All others	7	9	16	.015
Total	48	45	93	

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Failure to extract is generally regarded as the most serious of the common M16A1 malfunctions. Yet, in the WSEG test, 67 percent of all failures to extract were corrected by immediate action on the part of the firer without field stripping or the use of tools. 27 percent were corrected by the firer without using special tools but only a cleaning rod or other aid normally available to him. Only 6 percent required armorer assistance.

WSEG was the first to report a predominance of failures to eject.[77] While 83 percent of the failures to eject were immediately cleared by the firer, 7 percent required the attention of an armorer.[78] The high incidence of failures to eject suggests the need to examine the ejection pattern of the M16A1.

The M16 Review Panel's examination of the WSEG report and the statistical analyses included in the report suggests the following hypothesis: The M16A1 weapon system is particularly sensitive to changes in operating energy levels. Many of the WSEG results support this hypothesis, and none refute it. Significant data are available for a plausibility argument for the hypothesis, although

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[77] Many of which are spinbacks — the cartridge case ejects but is tipped in clearing the weapon so as to "spin" back into the ejection port and block the forward movement of the bolt and bolt carrier.

[78] Only 4 ejection springs were replaced on the 192 M16A1's under test, each of which fired about 6,000 rounds.

proof must await engineering work by USAWECOM and USATECOM. The following points are pertinent:

1. M16A1's with the new buffer and firing ball propellant ammunition had about one-third the malfunctions experienced by those firing IMR propellant, which develops lower energy levels and results in cyclic rates which approach the lower allowable limit.

2. Pretest firings of the M16A1's shipped direct from the factory showed malfunction rates significantly higher than those subsequently observed in the test, especially with IMR propellant. This change in malfunction rate is attributed to the "wearing-in" of the operating parts, and implies sensitivity to initially higher coefficients of friction.

3. For magazines loaded with both 18 and 20 rounds, using both IMR and ball propellants, most malfunctions occurred on the first or second rounds. The first round feeding cycle has energy from the action spring release of the bolt, and the second round is powered by energy from firing the first round, in this test a tracer round, with a lower charge than a ball round. Also, the frictional forces impeding the forward motion of the bolt carrier are greater, with a full, or nearly full, magazine. A detailed analysis of the WSEG data is required to determine the correlation between automatic and semiautomatic fire and the number of malfunctions on the first and

second rounds in the magazines. The following is a tabulation of data on the percent of malfunctions by round number in the magazine:

Round Number in Magazine	Percentage of Malfunctions Ball Propellant	IMR Propellant
First	23	12
Second	13	25
Other[a] (3 to 20)	4	4

[a] Average percent of malfunctions for each remaining round. Detailed anlysis of weapon functioning and of the specific types of malfunctions that were predominant when the first or second rounds were fired is necessary to provide an understanding of the performance phenomenon revealed in the above data.

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4. When IMR propellant is used the malfunction experience varies among M16A1's significantly more than when ball propellant is used. This fact suggests that marginal energy levels are developed with IMR propellant when the new buffer is used.

5. With the chrome plated chambers, which presumably reduce the frictional forces impeding cartridge case extraction, the use of ball propellant resulted in a higher overall malfunction rate but lower failure to extract rate than that experienced with ball propellant and the unchromed chamber. The IMR propellant and unchromed chamber combination had more malfunctions than any other propellant and chamber combination. Thus M16A1 functioning also seems extremely sensitive to increased, as well as decreased, operating energy.

6. In each environment (beach, rain forest, swamp, and uplands), M16A1's using IMR propellant had more malfunctions and greater variance of the malfunction rate between firing periods than did M16A1's with ball propellant. This fact suggests the sensitivity of the M16A1 system to energy levels.

More detailed compilations of the malfunction data recorded in the WSEG report are presented in Inclosure 6-2, Tables 43 through 48.[79] The tables show data for different propellant and chamber finish combinations by severity and type of malfunction. The malfunctions encountered in the WSEG test were grouped into three categories according to relative severity.

> Category I — Malfunctions which were corrected by immediate action on the part of the firer. The immediate action taken was appropriate to the type of weapon and included manually operating the bolt or withdrawing a spent case with the fingers, but did not include field stripping and did not require the use of tools.
>
> Category II — Malfunctions which could not be corrected by Category I action, but were corrected in the field by the shooter by field stripping and cleaning, lubricating, or minor adjustment without the use of tools (other than a cartridge or other aid normally available to the firer). This category did not include second echelon level work, but included actions which the riflemen could take during a temporary respite in combat.

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79 WSEG Report 124, Operational Reliability Test, M16A1 Rifle System, Feb 68.

Category III — Malfunctions which could not be corrected by Category I or Category II action, but which were correctable by an armorer with tools and parts.

Malfunctions for M16A1's firing both ball and IMR propellants by type of malfunction and category are shown in Inclosure 6-2, Table 43. The frequency of particular malfunctions is shown for each category, as well as the distribution of each malfunction by category. Tables 44 and 45 give a further breakdown of the data in Table 43 between M16A1's using ball propellant and those using IMR propellant.

The number and frequency of all malfunctions, and of malfunctions by type, for all four combinations of ball and IMR propellants, chromed and unchromed chambers are shown in Table 46. In comparing all these data, it will be observed that essentially equal numbers of rounds (approximately 272,000) were fired by each combination. Table 47 displays the number of malfunctions, by type, for the four combinations of chamber configurations and propellant types. The malfunction occurrences per 1,000 rounds by type, by propellant type, and by rifle configuration are shown in Table 48.

This review has raised questions about M16A1 system functioning and reliability, based on the WSEG report. Some of the observations, especially with respect to the severity and frequency of certain malfunctions, are not consistent with results from other tests. No answers are given here, because further analysis is required.

Colt Factory Reports on System Reliability, 1964-1968

The data presented here are based on the final inspection and reliability test summary reports submitted by Colt's to the U.S. Government Defense Contract Administration Services. By contract, these reports are required as part of the quality assurance program for the M16 rifle at Colt's Firearms Division of Colt Industries, Hartford, Connecticut.

The most extensive body of M16 system reliability data is contained in the function firing portion of the quality assurance test reports.[80]

Colt's Quality Assurance Functional Firing

Year	Weapons Fired	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
1964	55,363	3,691,394	5,156	1.40
1965	102,153	6,143,555	4,182	.68
1966	199,698	11,529,394	9,064	.79
1967	301,947	12,683,328	8,506	.67
1968[a]	58,887	2,429,115	1,066	.44
Total	718,048	36,476,786	27,974	.77

[a] January and February only

These data demonstrate general trends in M16A1 reliability, but are not indicative of field performance because they are based on all weapons tested, whether accepted or rejected; the firings

80 For detailed malfunction data, see Inclosure 6-2, Table 51.

were limited to two or three magazines per weapon, which does not allow for "wear-in" effects on performance; and tests were conducted on air-conditioned, indoor ranges.

In terms of performance data, the most significant portion of the quality assurance acceptance examination of M16A1 rifles is the 6,000-round reliability test. Rifle production lots vary in size, but never exceed one month's production. According to the government contracts with Colt's, at least one weapon per month, or per 10,000, will be fired in the 6,000-round reliability test. Further, should the test rifle fail, two additional rifles from the represented lot must pass the test or the entire lot will be rejected. A summary of the 6,000-round endurance tests, by year, is shown below.[81]

Colt's 6,000-Round Endurance Tests

Year	Number of Rifles	Rounds Fired	Malfunctions: Total Number	Malfunctions: Number per 1,000 Rounds
1964	39	213,499	124	.58
1965	29	160,184	81	.51
1966	26	151,143	78	.52
1967	39	219,836	93	.42
1968[a]	6	36,000	2	.06
Totals	139	780,662	378	.48

[a] January and February only.

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[81] For detailed malfunction data, see Inclosure 6-2, Table 49.

All quality assurance reports submitted by Colt Industries from March 1964 through February 1968 are summarized in Inclosure 6-2, Tables 50 through 55. Colt's final inspection reports are summarized in Table 50. These reports have four component parts: function firing, target inspection, accuracy inspection, and final inspection. The number of weapons fired for the function firing and the target and accuracy inspections portions is the sum of initial and repeat trials. Thus, a weapon which fires and fails and then refires and passes, is counted twice in the number of weapons fired, and once under the number of weapons accepted. In practice, each month since March 1965, Colt's has fired as many weapons as necessary so that the number accepted is equal to the number of weapons fired initially. Comparison of such data implies a 100 percent acceptance, but this is not true. Therefore, the method of presentation as discussed above was adopted. With respect to the final inspection portion of the quality assurance procedure, data for the initial and repeat inspections are presented separately, together with the total. Note that in totaling, the Colt's reports add the number of initial and repeat inspections to obtain the total number of inspections, which exceeds the actual number of weapons tested. In Table 50, the propellant lot number is recorded for both the function firing and the target inspection. The propellant used in each lot is indicated by lot number, in Inclosure 6-2, Table 56.

Data extracted from the f... : firing portion of Colt's final inspection report by mo and year is presented in Inclosure 6-2, Table 51. In particul , the total number of weapons fired (initial and repeat) and the total number of rounds fired are recorded by month, together with the number of weapons rejected for each type of malfunction, and the malfunction rate per 1,000 rounds. It should be noted that the average number of rounds fired per weapon has declined from 66.7 in 1964 to 38.8 in 1968.

Inclosure 6-2, Tables 52 and 53 summarize data reported in the Colt's 6,000-round reliability tests, giving the date of the test; rifle lot number; size of lot; weapon serial number; initial and final accuracy, velocity, and cyclic rate of fire; and total number of malfunctions and unserviceable parts. Table 52 lists rifle lots under contract number DA-11-199-AMC-508 (March 1964-April 1966), and Table 53 covers contract number DAAF03-66-C-0018 (May 1966 to February 1968).

Inclosure 6-2, Tables 54 and 55, summarize the data reported in the 6,000-round reliability tests, including the malfunctions and unserviceable parts, by type, by rifle lot number, and by contract.

Inclosure 6-2, Table 49, indicates the malfunctions reported during the 6,000-round reliability tests by month and year, the malfunction rates per 1,000 rounds, and the propellant used in the tests.

Analysis of the malfunctions reported by Colt's from March 1964 through February 1968 indicates an initial downward trend in the rate per 1,000 rounds from 1964 to 1965, an increase during 1966, and a continuing downward trend since then. Tables 6-13 and 6-14 below show selected malfunctions, by type, the number experienced, the percentage of overall malfunctions, the occurrence per 1,000 rounds, and the totals by year since 1964 for the 6,000-round endurance tests and functional firings, respectively. Although the malfunction occurrence per 1,000 rounds varies slightly between the two tables, the trends are comparable.

TABLE 6-13 — COLT'S 6,000-ROUND ENDURANCE TESTS MALFUNCTION SUMMARY, 1964 - 1968

Type of Malfunction	1964 No.	1964 % of Total	1964 No. per 1,000 Rounds	1965 No.	1965 % of Total	1965 No. per 1,000 Rounds	1966 No.	1966 % of Total	1966 No. per 1,000 Rounds	1967 No.	1967 % of Total	1967 No. per 1,000 Rounds	1968[a] No.	1968[a] % of Total	1968[a] No. per 1,000 Rounds
Failure to feed	27	21.77	.13	31	38.27	.19	32	41.03	.21	41	44.09	.19	0	.00	.00
Failure of bolt to remain to rear	23	18.55	.11	3	3.70	.02	1	1.28	.01	0	.00	.00	0	.00	.00
Failure to eject	39	31.45	.18	8	9.88	.05	7	8.97	.05	33	35.48	.15	1	50.00	.03
Failure to fire	0	.00	.00	2	2.47	.01	11	14.10	.07	2	2.15	.01	0	.00	.00
Failure to extract	1	.80	.00	2	2.47	.01	4	5.13	.03	0	.00	.00	0	.00	.00
Failure of bolt to close	2	1.61	.01	4	4.94	.02	2	2.56	.01	3	3.23	.01	1	50.00	.03
All others	32	25.81	.15	31	38.27	.19	21	26.92	.14	14	15.05	.06	0	.00	.00
Total	124	100.00	.58	81	100.00	.51	78	100.00	.52	93	100.00	.42	2	100.00	.06
Rounds Fired		213,499			160,184			151,143			219,836			36,000	

[a]January and February only.

TABLE 6-14 — COLT's FUNCTIONAL FIRINGS MALFUNCTION SUMMARY, 1964 - 1968

Type of Malfunction	1964 No.	1964 % of Total	1964 No. per 1,000 Rounds	1965 No.	1965 % of Total	1965 No. per 1,000 Rounds	1966 No.	1966 % of Total	1966 No. per 1,000 Rounds	1967 No.	1967 % of Total	1967 No. per 1,000 Rounds	1968[a] No.	1968[a] % of Total	1968[a] No. per 1,000 Rounds
Failure to feed	1,093	21.20	.30	1,020	24.39	.17	981	10.82	.09	2,109	24.79	.17	169	15.85	.07
Failure of bolt to remain to rear	57	1.11	.02	227	5.43	.04	346	3.82	.03	264	3.10	.02	24	2.25	.01
Failure to eject	2,322	45.03	.63	495	11.84	.08	2,674	29.50	.23	243	2.86	.02	82	7.69	.03
Failure to fire	481	9.33	.13	689	16.48	.11	787	8.68	.07	647	7.61	.05	118	11.07	.05
Failure to extract	342	6.63	.09	595	14.23	.10	1,388	15.31	.12	2,190	25.75	.17	0	.00	.00
Failure of bolt to close	3	.05	.00	35	.84	.01	230	2.54	.02	548	6.44	.04	72	6.75	.03
All others	858	16.64	.23	1,121	26.81	.18	2,658	29.32	.23	2,505	29.45	.20	601	56.38	.25
Total	5,156	100.00	1.40	4,182	100.00	.68	9,064	100.00	.79	8,506	100.00	.67	1,066	100.00	.44
Rounds Fired	3,691,394			6,143,555			11,529,394			12,683,328			2,429,115		

[a]January and February only.

C. Analysis of M16 Reliability

The M16 (AR15) was a surprisingly reliable weapon in the early phase of its development; it outperformed the M14 (T44E4) in the first evaluation in 1958.[82/] At that time, the AR15 had been under development less than a year and the M14 had been under developmental testing for approximately 10 years. The AR15's performance impressed many people in and out of the Defense Department, and the rifle was later sought by the Air Force as its standard shoulder weapon. Evaluation and testing of the AR15 continued through 1962, and the results indicated that its reliability, although in need of improvement, was approaching that of the M14. The tests conducted during that period show the overall malfunction rate of the AR15 to have been 14.3 per 1,000 rounds, as compared to the M14's 11.6 per 1,000 rounds. Figure 1 indicates the overall malfunction rate of the AR15 (M16A1) from the first evaluation in 1958 to the February 1968. Included, for comparative purposes, is the malfunction rate of the M14 where the two weapons were subjected to the same tests or evaluations, and the rates experienced at Colt's factory during the function firing portion of the acceptance tests and the 6,000-round endurance tests. A dramatic improvement in the AR15's reliability is shown during the 1962-63 comparative

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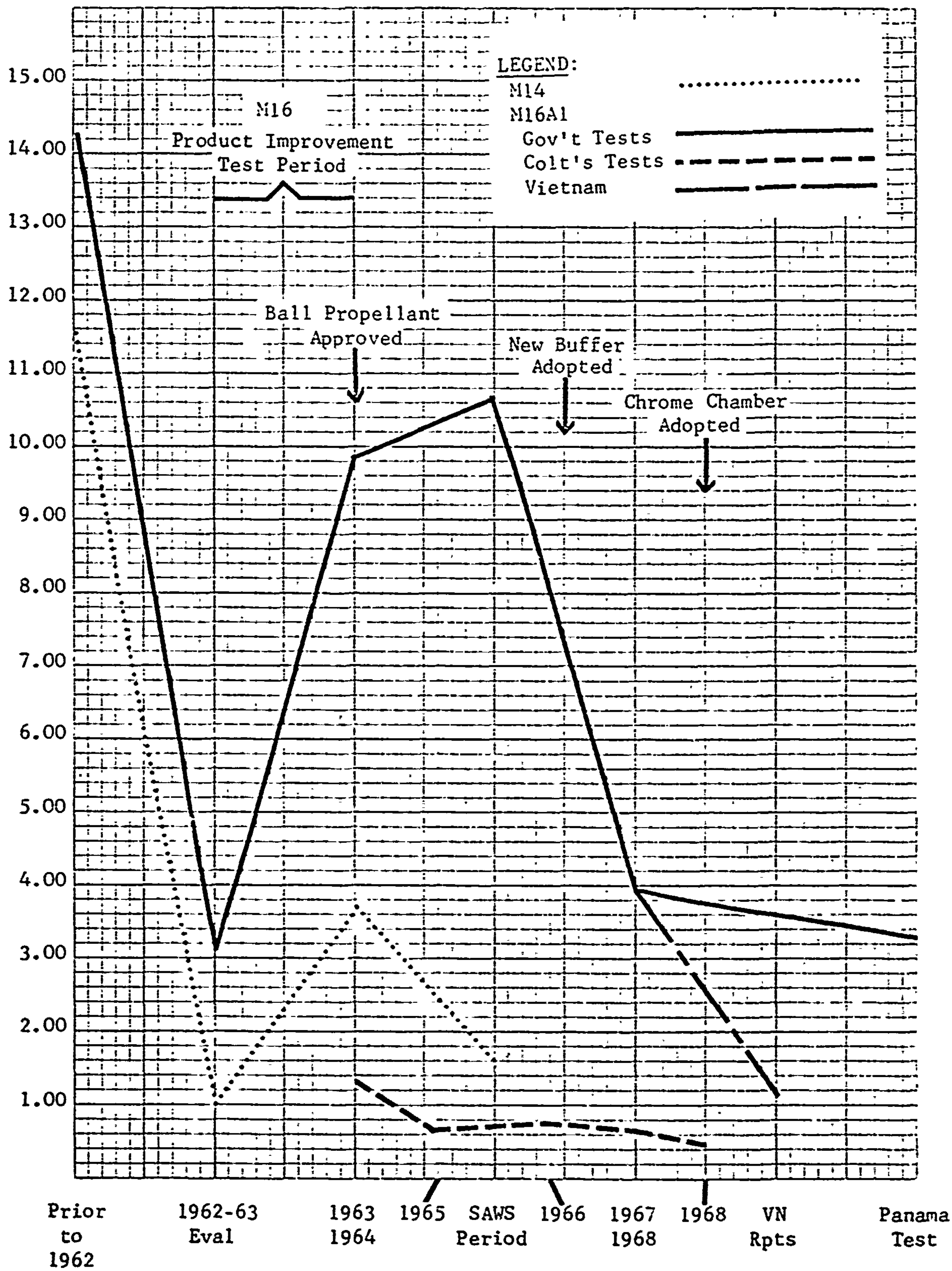
82 USAIB Evaluation Report on the Armalite (AR15), 27 May 58.

Figure 6-1 — OVERALL MALFUNCTION RATES PER 1,000 ROUNDS



evaluation of the AR15 and M14. This greater reliability can be attributed to improvements made in the weapon by the manufacturer. It should be noted that the improved reliability was achieved despite a considerable amount of trouble with the magazines and ammunition (blown primers) experienced during the 1962-63 evaluation.

The period 1963-64 saw an increase in the malfunction rate for both the M16 and M14. However, the increase for the M16 can be attributed chiefly to the fact that most of the tests conducted during the period were for the purpose of evaluating improvements in the AR15, including: firing pin restraining devices, charging handle changes, bolt assist devices, magazine catch springs, primer sensitivity, chamber dimensions, magazine designs, and alternate propellants for the 5.56mm round. In testing, the prototypes of the product improvements often adversely affected the reliability of the weapon and caused an overall increase in the malfunction rate.

In June 1964 the use of ball propellant in 5.56mm ammuntion was approved. With ball propellant came increased operating energy, and an increase in the cyclic rate of fire and the overall malfunction rate. This problem was recognized, and a new buffer (action spring guide assembly) was designed, tested, and adopted in December 1966.[83]

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[83] See Appendix 1 for test procedures, and Appendix 9 for the audit trail of M16A1 weapon and ammunition system tests.

The new buffer had been under consideration by Colt's for the purpose of eliminating carrier bounce and the resulting failures to fire because of light blows by the firing pin, so that when the high cyclic rate was recognized as a problem, the buffer design was modified to solve both problems. In late 1966, complaints of high malfunction rates of the M16A1 in Vietnam caused a technical assistance team to be sent from USAWECOM to determine the trouble (see Vietnam reports on reliability above). One of the recommendations of the team was that the chamber of the M16 be chrome plated. The introduction of the chrome plated chamber in September 1967 has reduced failures to extract and the overall malfunction rate but has increased other types of malfunctions: failure to eject, failure to fire, and failure of the bolt to remain to the rear.

Figures 6-2 through 6-7 indicate the occurrence, per 1,000 rounds, of selected malfunctions, and will be discussed individually below. It is emphasized that the data displayed in the figures are not "hard" data because of the wide range of test conditions, controls, and malfunction reporting procedures used in the various tests and evaluations; however, the displays do give an indication of the M16A1's reliability over a considerable time and are useful in identifying trends. Each figure shows graphically the history of the occurrence rate as reported in the various Army, Air Force, and Marine Corps tests conducted. Also shown are the rates experienced at Colt's plant for both function firing (every rifle produced), and the 6,000-round endurance firing (one rifle per production lot) and the malfunction data reported by the Marine Corps in Vietnam. As previously indicated, the Marine Corps data are incomplete, and therefore are not shown on every figure. The combat reports of the Marine Corps indicate that the occurrence rate is lower for all malfunctions, except failure to extract, than that experienced in testing.

Failure of the bolt to close, Figure 6-2, follows the same trend as that of the overall malfunction rate through the end of 1967. The results of the Panama test in January 1968 indicate an increase, rather than a decline, of this malfunction. As has been the case in previous tests with troops, many of these malfunctions were caused by the soldier's "riding the charging handle forward" and thus impeding the bolt's forward movement, producing a failure to close. The Colt's rate indicated a slight decrease in this malfunction during 1968. This malfunction is not serious and can be corrected by use of the bolt assist device (see Inclosure 6-1, FBC, for detailed discussion).

Figure 3 indicates the occurrence per 1,000 rounds of failure of the bolt to remain to the rear. A significant reduction in this malfunction was achieved with the introduction of the new buffer, since most ammunition used in tests was loaded with ball propellant at that time. Again the malfunction is not a serious

Figure 6-2 — FAILURE OF BOLT TO CLOSE

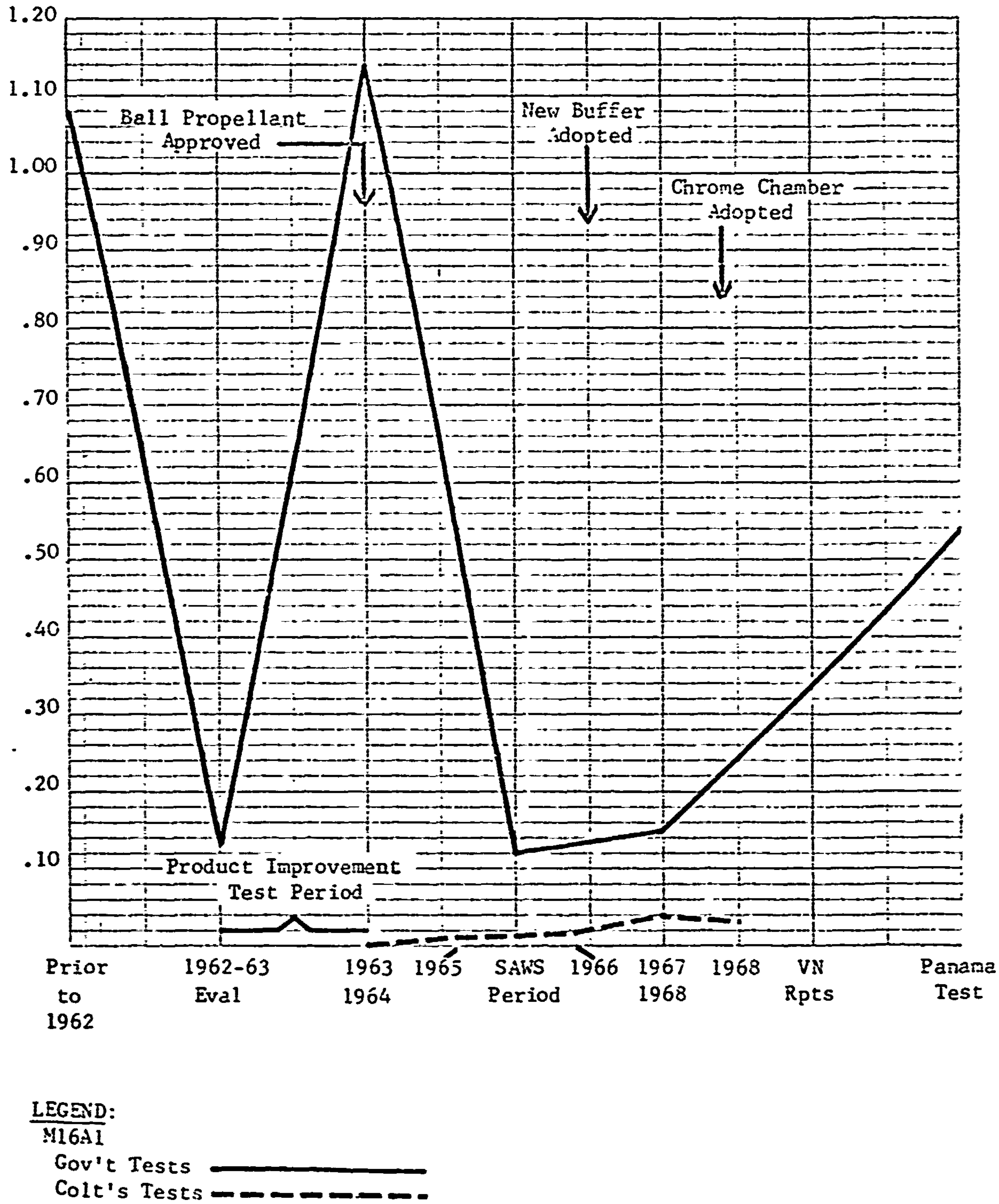
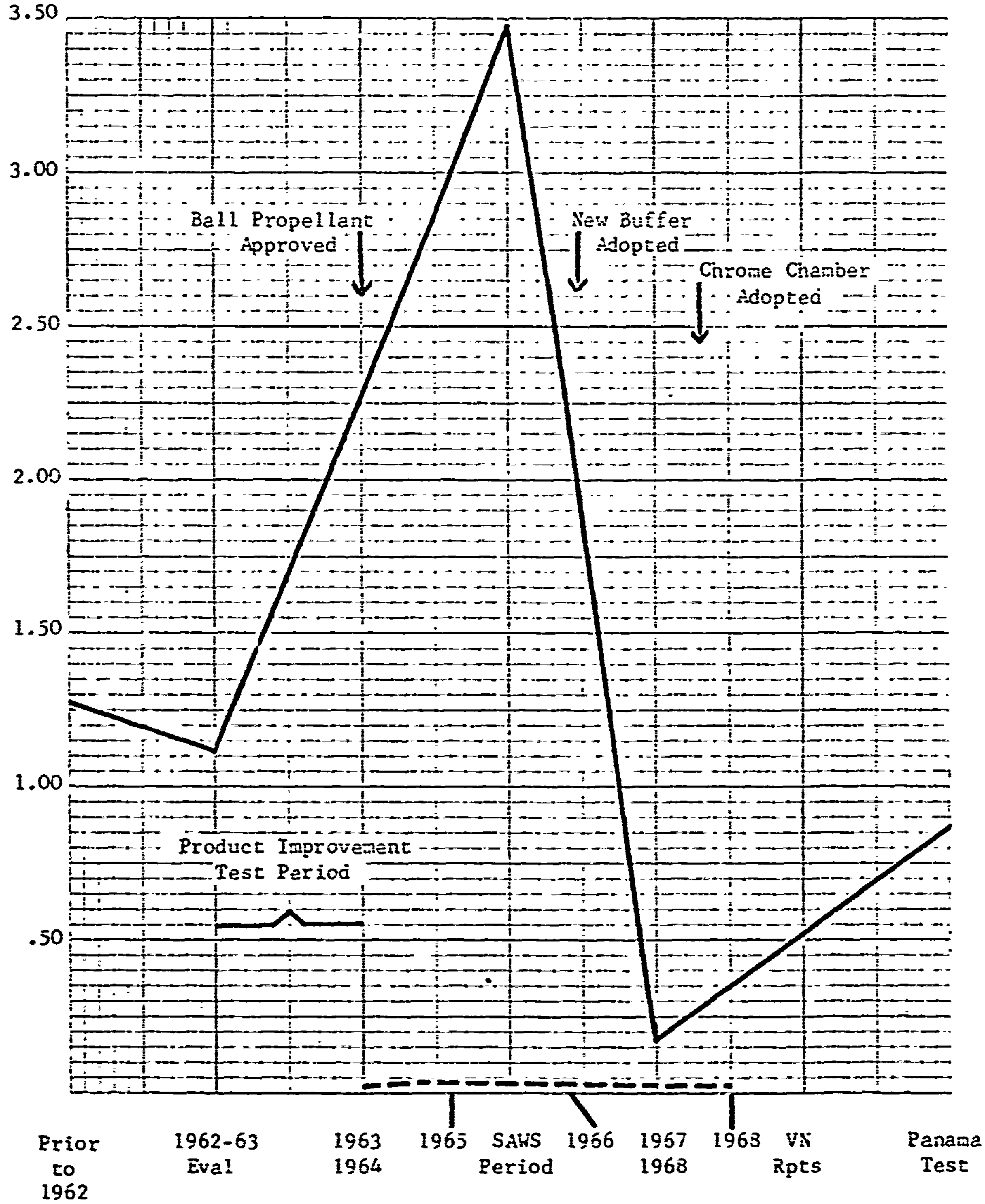


Figure 6-3 — FAILURE OF BOLT TO REMAIN TO REAR



LEGEND:
M16A1
Gov't Tests
Colt's Tests

one and can easily be corrected (see Inclosure 6-1). A slight increase in this malfunction is indicated for the last test. The rate increased because IMR propellant, which provides less operating energy, was used in M16A1's with the new buffer. The Colt's rate indicates little if any change through the years, primarily because prior to the introduction of the new buffer only IMR propellant loaded ammunition was used in Colt's tests and also because ball propellant loaded ammunition has been used for testing almost exclusively since the buffer change in December 1966.

Failures to feed declined significantly in tests through the SAWS test period (Figure 6-4.) because of improvements to the magazines used in the earlier testing, and because of the increased operating energy provided by the adoption of ball propellant. The rate increased when the new buffer was adopted because of the reduction in operating energy, and has shown a decrease since then with the use of the chrome plated chamber, which tends to increase the operating energy available because of the reduced friction encountered during extraction.

Incidence of failure to fire (Figure 6-5) decreased steadily until early 1964 with improvements in the weapon and its ammunition. Upon the adoption of ball propellant, however, the rate rose sharply because the high cyclic rate of fire induced carrier bounce and resulted in light blows. When the new buffer was adopted, the

Figure 6-4 — FAILURE TO FEED

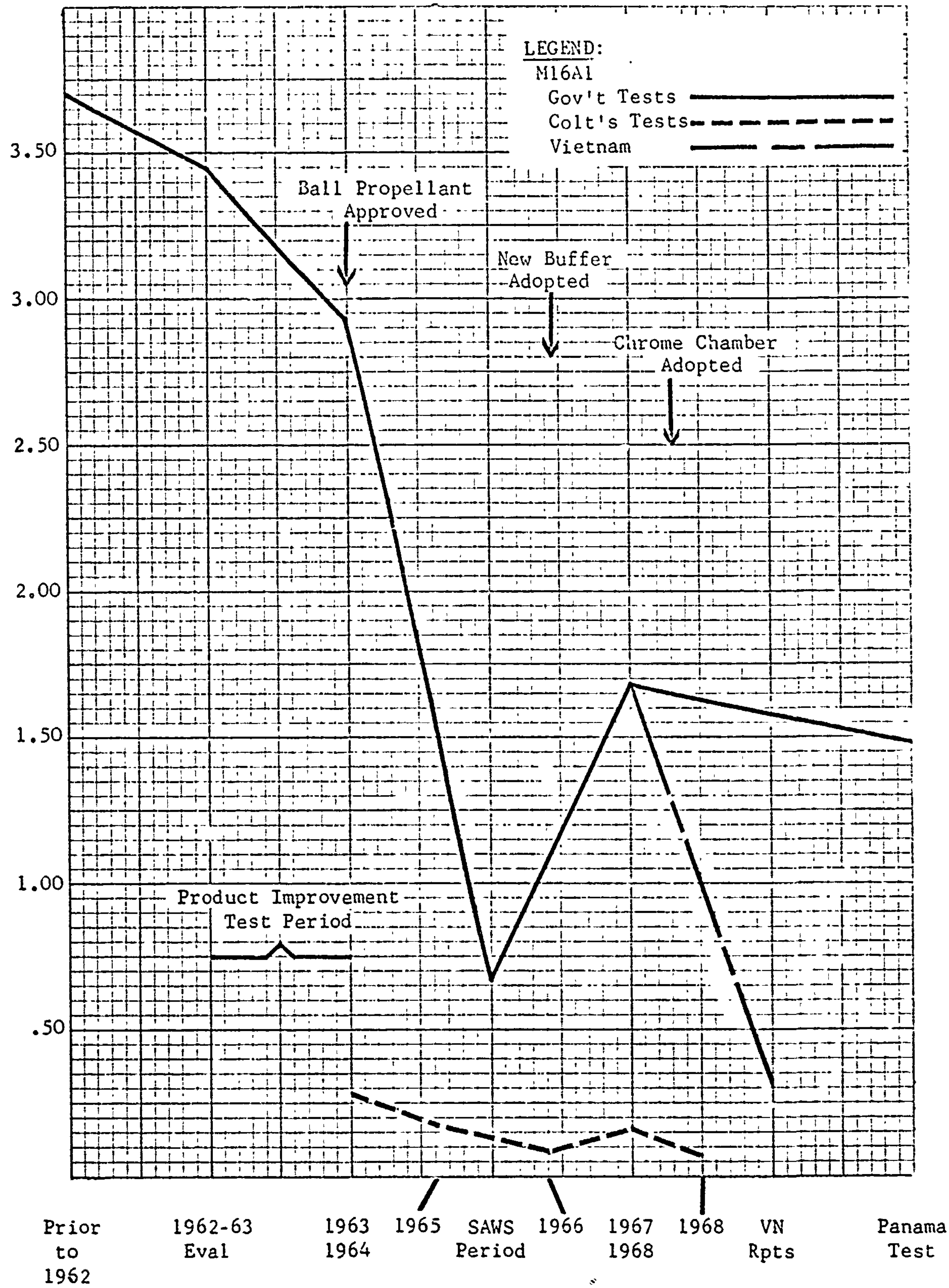
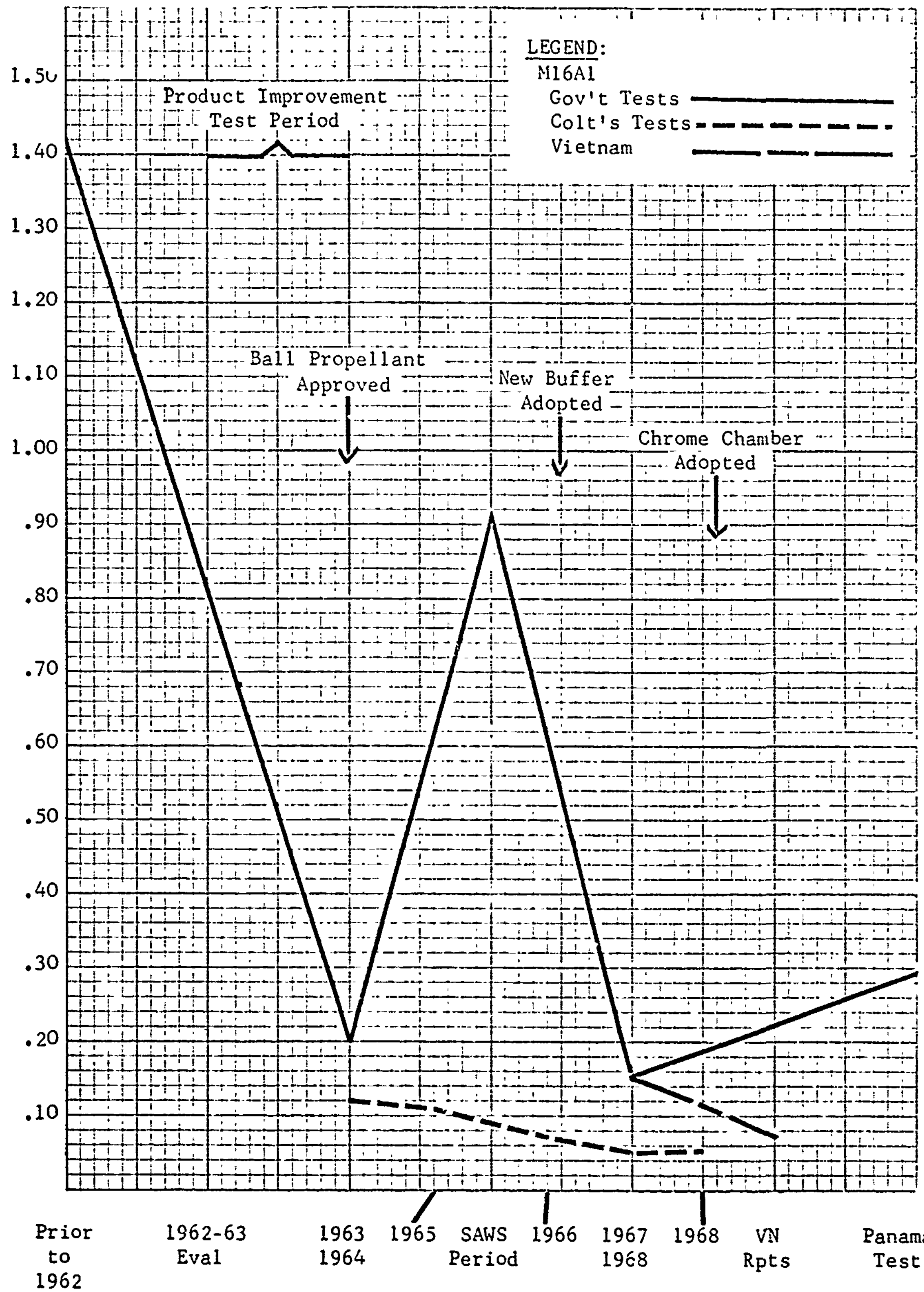


Figure 6-5 — FAILURE TO FIRE



rate again declined sharply. The rate has risen slightly since the incorporation of the chrome chamber, probably because of the slight increase in operating energy afforded by the reduction in energy required for extraction.

Failures to eject (Figure 6-6) follow the same pattern as the failures to fire, again showing the sensitivity of the M16A1 to minor variations in operating energy level. This malfunction is bothersome, but most of the time can be easily cleared (see Inclosure 6-1).

The most difficult malfunction to clear, and the one that has received the most publicity, is failure to extract (Figure 6-7). Its history shows an initial decline through 1962, a sharp increase during the product improvement tests, 1963-64, and a sharp decline after adoption of ball propellant, presumably because of the increase in operating energy. A slight increase is noticeable upon adoption of the new buffer, but the rate declines when the chrome chamber is introduced. The high incidence rate reported by the Marine Corps can be attributed to two factors: (1) a failure to extract is more likely to be reported by a man in combat because it is often difficult to clear, and (2) the majority of the weapons in the hands of the marines when the data were collected, did not have chrome plated chambers, and many had pitted chambers. A recent technical inspection of the Marine Corps M16A1's revealed

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Figure 6-6 — FAILURE TO EJECT

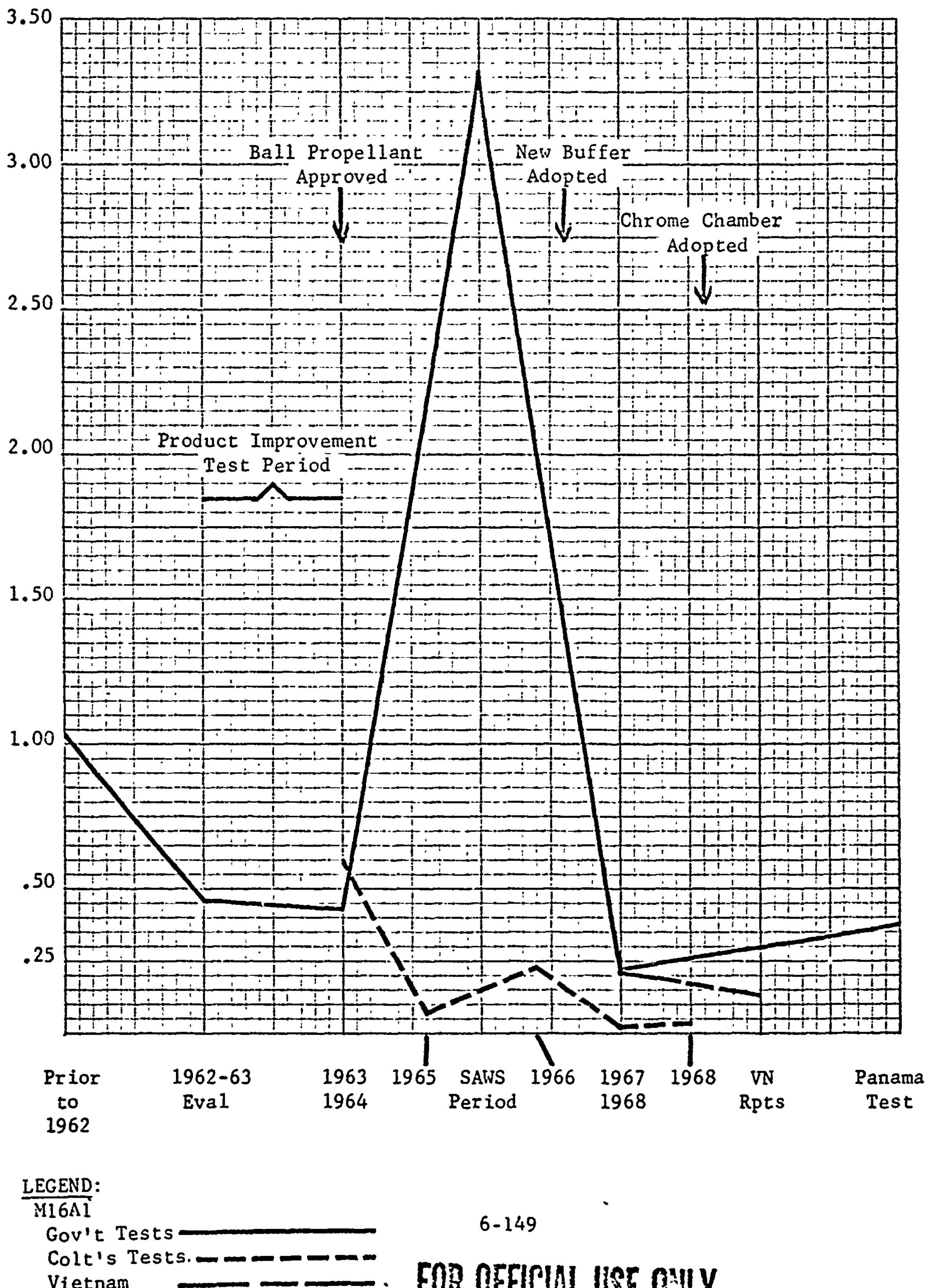

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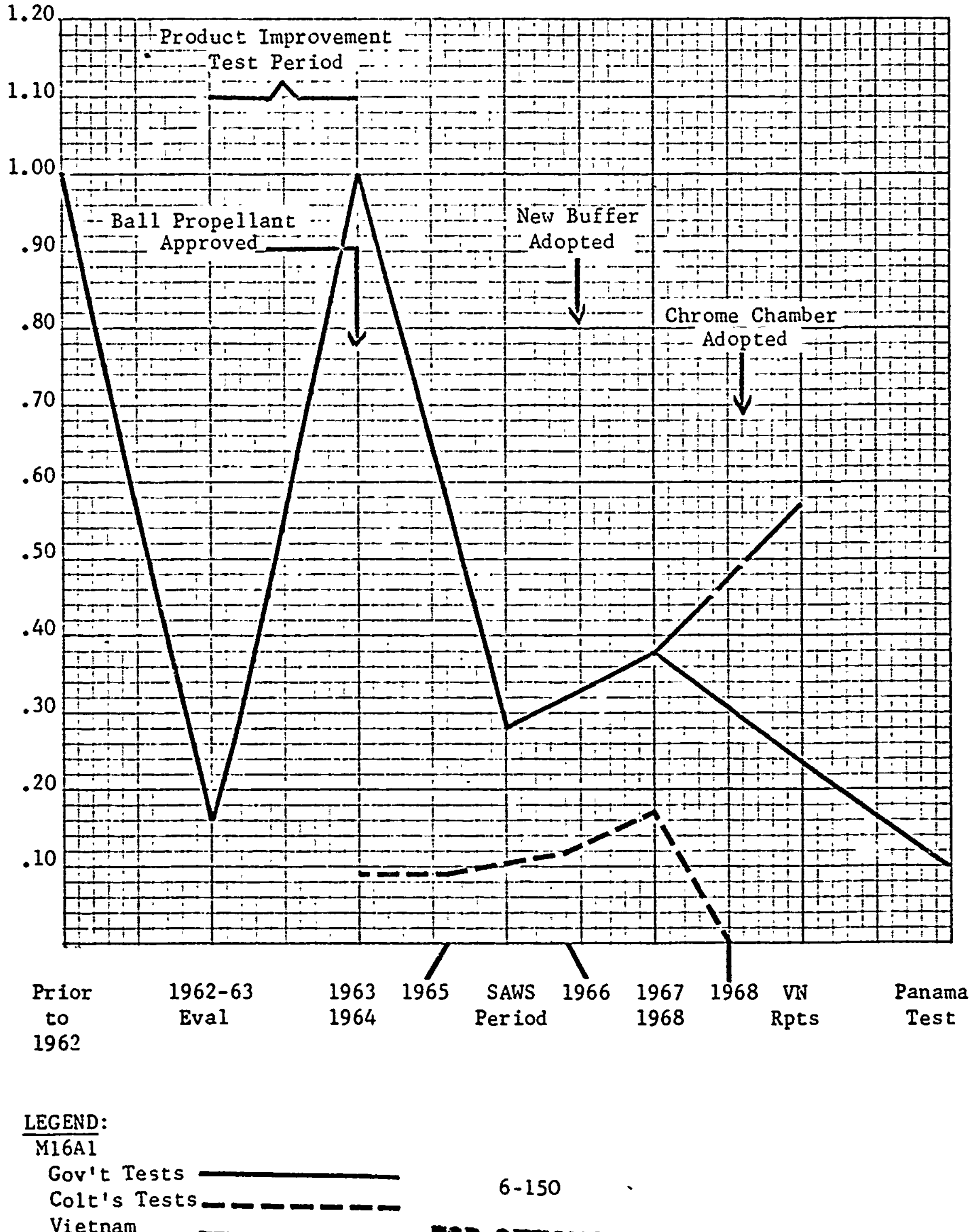
Figure 6 7 — FAILURE TO EXTRACT



that approximately 65 percent of the rifles were unserviceable because of pitted chambers.[84] These unserviceable weapons were immediately replaced. It should also be noted that the Colt's rate increases steadily until the introduction of the chrome chamber, and then drops to zero thus far in 1968.

The final figure (Figure 6-8) shows the historic rate of all other types of malfunctions. The rate fluctuations follow generally those of the overall malfunction rate (Figure 6-1), but shows a sharper rate of decrease in the last two years. This is indicative of the overall improvement of the M16A1's currently being produced.

Since malfunction rates are considerably higher for rifles fired in the automatic mode (see the WSEG test), and since the M16A1 is used in the automatic mode one-third of the time in combat (see Appendix 7, Vietnam Surveys), its malfunction rate is expected to be higher than that of the M14, which is used primarily in the semiautomatic mode.[85] It is therefore doubtful that the M16A1 rifle malfunction rate in the field will ever become consistently lower than that of the M14.

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84 Reported to the M16 Review Panel verbally by a Representative of the U.S. Marine Corps during the Panel's Vietnam survey.

85 Only M14A2's are authorized the selector lever.

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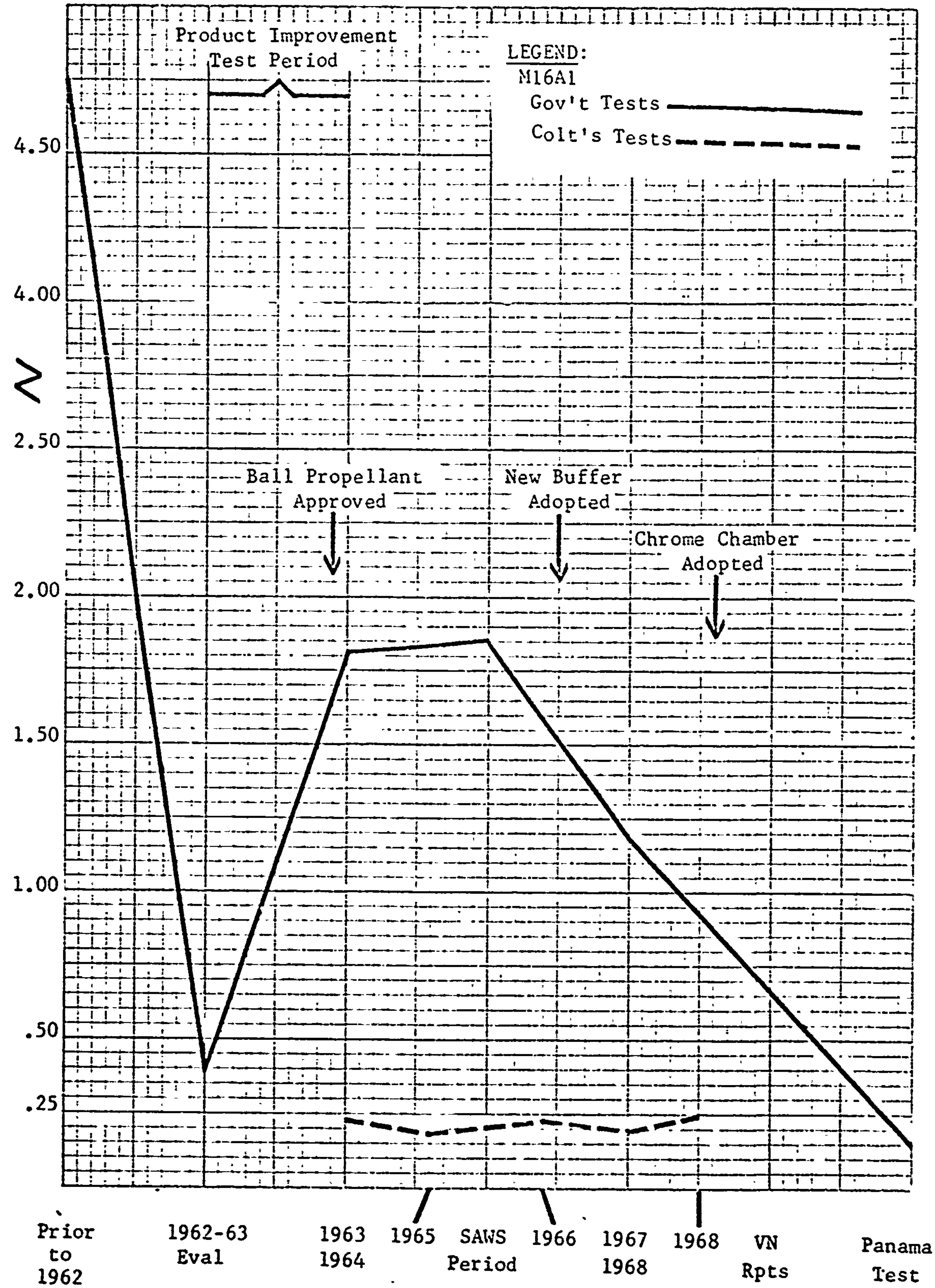
Figure 6-8 — ALL OTHER MALFUNCTIONS



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D. Conclusions

1. The reliability data reported in the various tests and evaluations discussed above do not provide a statistically significant basis for an engineering analysis, nor do they provide a clear reason for the occurrence and fluctuation of certain malfunctions. (See the evaluation of test policy and procedures, Appendixes 1 and 2.)

2. The malfunction data extracted from the tests and evaluations that are displayed in this appendix do not represent absolute numbers, but are useful only in identifying reliability trends over periods of time. (Appendix 2, Analysis of Test Procedures).

3. Except in the first evaluation in 1958, the M16A1 rifle has been, and continues to be, less reliable than the M14 rifle. A higher malfunction rate is an inherent characteristic of the fully automatic rifle in general, a fact that was most recently confirmed in the WSEG test.

4. The reliability of the M16A1 rifle is sensitive to minor variations in the operating energy level.

5. Changes were made in the M16A1 and its ammunition by trial and error. Little is known about the effect of variations in internal ballistics on functional reliability of the system, nor where detailed studies in this area initiated before 1968. (See Appendixes 1 and 2, Testing and Evaluation.)

6. The function firing tests and the 6,000-round endurance tests conducted at Colt's do not provide data which are indicative of the actual performance that can be expected of the M16A1 in the hands of troops. (For quality assurance, see Appendix 5.)

7. The value of the 6,000-round endurance tests, for the M16A1 rifle conducted by USATECOM and by Colt's is limited because they do not represent a test of the service life of the weapon.

8. The lack of cleaning materials and the lack of proper training contributed heavily to the high M16A1 malfunction rates experienced in Vietnam in late 1966 and early 1967. (See Appendix 3, training, and Appendix 7, Vie surveys.)

9. The functional reliability of the M16A1 rifle, as currently produced with the new buffer and chrome plated chamber, is satisfactory when the weapon, ammunition, and magazines are properly maintained and lubricated, and provided that ball ammunition loaded with ball (WC 846) propellant, and tracer ammunition loaded with IMR propellant are used.

10. Over 50 percent of the malfunctions currently being experienced by the M16A1 system are failures to feed and can be attributed primarily to the standard magazine.

11. A detailed engineering analysis of the M16A1 system is required to improve its reliability further.

DEFINITION, CAUSE, AND CLEARANCE OF M16A1 RIFLE MALFUNCTIONS

Inclosure 6-1

Definition, Cause, and Clearance of M16A1 Rifle Malfunctions

These definitions of malfunctions apply to all such abbreviations used in Appendix 6 and in the tables contained in Inclosure 6-2.

As most malfunctions cannot be sensed by the shooter until after he has pulled the trigger, and consequently released the hammer, those immediate actions which may clear a malfunction by manually completing bolt closure do not permit a resumption of firing until the rifle is also recocked.

As noted in the following pages, a number of the cited methods of clearing malfunctions may inadvertently damage the magazine. While these methods are often necessary under combat conditions, tools are used during all tests to facilitate clearing of jammed rounds without damage to the magazines where possible.

Inclosure 6-1

Definition, Cause, and Clearance of M16A1 Rifle Malfunctions

Abbreviation	Definition	Cause	Clearance
BCE	The bolt stop catch engages the bolt carrier instead of the bolt This designation applies only when the malfunction occurs after the last round of a magazine is fired. (See BCS).	Possible causes are: a worn or broken bolt stop catch; the failure of the magazine follower to move the bolt stop catch upward quickly enough; or a dirty bolt catch or magazine.	BCE can be cleared quickly by pulling the charging handle all the way to the rear while the empty magazine is still in the weapon. Preventing a recurrence may require cleaning the weapon, the magazine, or both, and replacing the magazine or bolt catch (usually a Type III malfunction).
BCS	The bolt stop catch prematurely engages either the bolt or bolt carrier during firing, thus halting the forward movement of the recoiling parts and producing a stoppage.	BCS can be caused by a weak or broken bolt stop catch spring, wherein the vibration of the rifle being fired jars the bolt catch stop upward enough to engage the bolt or bolt carrier. BCS can also be caused by foreign matter in the magazine, which engages the tang of the bolt stop catch and forces it upward, thus engaging the bolt or bolt carrier before the last round in the magazine is fired.	BCS normally can be cleared by releasing the bolt stop catch; if BCS recurs the magazine will have to be cleaned or changed, or the bolt stop catch spring replaced.

Abbreviation	Definition	Cause	Clearance
BOB	The bolt overrides the base of the round. A definitive type of failure to feed.	This malfunction occurs when the base of the round to be fed is not presented in a fully elevated position in front of the forward moving bolt. It may be caused by an underpowered or short recoil of the bolt and carrier, or by a failure of the cartridge follower in the magazine to elevate fully the dual cartridge columns. The jammed and damaged cartridge is most often only partially stripped from the magazine.	BOB can rarely be cleared quickly, and if the bolt assist device is used as a first corrective action the degree of severity of the malfunction is greatly increased. Clearance of the stoppage requires retracting the charging handle only far enough to permit the base of the round to move upward in front of the bolt and then releasing the charging handle. Pulling the charging handle fully to the rear may cause a double feed. In some instances of this malfunction the round to be fed has been driven forward into the chamber after impact by the bolt and a second round partially stripped forward from the magazine jamming the bolt in an "override" position. In order to clear the weapon, the bolt must be retracted and held rearward while the the magazine is removed. Usually some force is needed to withdraw the magazine because of the partially stripped round, and this force may be sufficient to spread or damage the lips of the magazine.

Abbreviation	Definition	Cause	Clearance
BP	Broken part; a part of the weapon is broken or severely cracked during firing.		The part must be replaced. If the part is important to the functioning of the weapon, it will normally be classed as a Type I malfunction. Other parts, such as the hand guard, can be broken or cracked without affecting the performance of the weapon and are classed as Type III malfunctions.
BUB.	The bolt underrides the base of the round. A definitive type of failure to feed, in which the base of the round to be fed is elevated above the top of the face of the forward moving bolt.	This usually is caused by damaged (bent) lips of the magazine, which allow the base of the round, or the entire round, to be positioned above the face of the forward moving bolt; the jammed and damaged cartridge is wedged between the top of the bolt and the top of the upper receiver.	Clearing can rarely be done quickly and if the bolt assist device is used as a first corrective action, the degree of severity of the malfunction is greatly increased. Clearing the stoppage requires removal of the magazine and pulling the charging handle all the way to the rear, thus allowing the damaged round to fall out of the receiver. (Occasionally the damaged round will have to be pried loose after the magazine is removed and the charging handle is all the way to the rear.) Pulling the charging handle fully to the rear and releasing it without removal of the magazine will usually result in a double feed.

Abbreviation	Definition	Cause	Clearance
CHU	The charging handle unlatches and moves rearward during firing (applies usually to the XM16E1 rifle). The handle moves to the rear, striking the firer in the face (usually without injury to him).	This malfunction is usually caused by a weak or broken charging handle latch spring; a worn or broken charging handle latch; or a worn notch in the upper receiver. This malfunction does cause an interruption in firing because it startles the firer.	Since the charging handle latches have been redesigned on the newer versions of the M16, this malfunction should be extremely rare in the future. When it does occur the defective part must be replaced.
COEC	The bolt closes on an empty chamber. A definitive type of failure to feed.	COEC occurs either as a result of a failure of the cartridge follower to elevate fully the round to be fed, or as a result of short recoil of the bolt and carrier. The malfunction is closely related to a bolt override, although the consequences of a COEC are much less than those of a BOB.	The malfunction is not difficult to clear and firing can be resumed quickly by fully retracting and then releasing the charging handle. If the bolt assist device is inadvertently used instead of the charging handle, the error only delays but does not further increase the difficulty of correctly clearing the malfunction.
DF	Double feed	DF is usually caused by a damaged magazine (spread lips). The distinction between a double feed and a bolt override of a second round, as discussed above under BOB, is that in the case of a DF the bolt is	Clearing requires full retraction of the bolt and removal of the magazine. The removal of the magazine may result in damage to the lips of the magazine.

Abbreviation	Definition	Cause	Clearance
DF (Cont'd)		behind both the cartridge to be fed and the next round and both rounds are simultaneously being forced into the chamber.	
DFP	Defective part.	The part was not manufactured to specifications.	Replace the part.
DP	Damaged part.	The part was damaged during firing.	Replace the part. See above, BP.
FBA	Failure of the bolt assist. The bolt assist device fails to chamber a round or to lock the bolt when it is used.	This malfunction occurs when excessive dust, mud, dirt, or rust has accumulated on the operating parts of the weapon or within the bolt assist device itself. It is caused more frequently by attempting to chamber a dented or deformed round.	Clean and lubricate the weapon if the malfunction is caused by dirt or rust, or extract and discard the deformed round.
FBC	Failure of the bolt to close or to lock completely. (See also FF, below.)	This malfunction can be caused by a dirty weapon, dirty magazine, or dirty weapon, or dirty ammunition. It is quite common in extreme low temperature tests, dynamic dust tests, saltwater immersion tests, and mud tests. It can also be caused by dented ammunition or a dirty (rusty or corroded) chamber. (See also FF, below.)	If the malfunction is recognized before the trigger is pulled, it can usually be reduced quickly by the use of the bolt assist. (See also FF, below.)

Abbreviation	Definition	Cause	Clearance
FBR	Failure of the bolt to remain to the rear after the last round is fired.	FBR is usually caused by the failure of the bolt catch to engage the bolt at very high cyclic rates of fire.	The only problem associated with this malfunction would be some initial uncertainty on the part of the gunner as to whether or not a firing stoppage had occurred. However, if the empty magazine is removed prior to fully retracting the chargining handle, the bolt cannot easily be latched rearward. Attempting then to insert a fully loaded magazine against the pressure of the bolt carrier becomes difficult and in some instances may cause damage to the magazine lips.
FCB	Fired on closure of the bolt without the trigger's being intentionally depressed; usually called a "slam fire."	This malfunction occurred in early models of the AR15. Subsequently changes were made in the firing pin and primer sensitivity which make this malfunction now highly improbable. It can occur if a piece of foreign matter is on the face of the bolt and in contact with the primer when the bolt moves forward into the battery.	The weapon must be cleaned and the hammer and sear checked for wear.

Inclosure 6-1

Abbreviation	Definition	Cause	Clearance
FF	Failure to feed	FF occurs as a result of insufficient energy of the bolt and carrier to carry through successfully the feeding and chambering operations. The round is in front of the bolt but is usually not in a jammed position.	The malfunction can usually be cleared quickly by use of either the bolt assist device or the charging handle; if the latter is used, only a partial rearward retraction is employed. Full retraction and release of the charging handle may cause a double feed.
FF-1	Failure to feed the first round of a fully loaded magazine.	This malfunction occurs when the bolt, after being released by depressing the bolt stop release lever, lacks sufficient energy to feed and chamber the first round of a fully loaded magazine.	FF-1 can usually be quickly cleared either by use of the bolt assist device or by retracting the charging handle. However, use of the charging handle may occasionally cause a double feed.
FFR	Failure to fire.	Failure to fire is usually associated with a light firing pin indent on the primer. While it may be caused by a weak hammer spring, or by a dirt-laden or fouled firing pin, it is most often the result of the bolt carrier's being somewhat out of "battery position," that is not fully forward at the time the hammer falls. This permits the hammer to strike the carrier rather than impact the firing pin directly.	FFR is not difficult to clear and firing can be resumed quickly by fully retracting and then releasing the charging handle. If the bolt assist device is inadvertently used instead of the charging handle, the error only delays but does not further increase the difficulty of correctly clearing the malfunction.

Abbreviation	Definition	Cause	Clearance
FJ	Failure to eject.	Ejection and extraction failures occur when a fired case fails to clear the ejection port causing the bolt to stop in its forward motion. The next live round to be fed is often in the chamber but usually not in a jammed position.	Corrective action must be limited to proper manipulation of the charging handle, as fully retracting the charging handle may result in a double feed. Use of the bolt assist device will only increase the severity of the stoppage.
FJR	Freely ejected round.	A live round is ejected simultaneously with a fired case. The malfunction may or may not cause a stoppage (jam); usually it is caused by a defective magazine.	Replace the magazine.
FS	A failure of the selector or the sear mechanism, often resulting in a runaway gun.	This malfunction is caused by a worn, damaged, or dirty sear, selector or hammer. (See also BP, DP, and FCB, above.)	Clean the weapon and replace parts if required.

Inclosure 6-1

Abbreviation	Definition	Cause	Clearance
FTR	A failure of the trigger to return to its normal position after it has been released.	The weapon cannot be fired until the trigger is pushed forward and then pulled again. FTR is usually caused by dirt, rust, or corrosion on the trigger or trigger pin, but can also be caused by a weak or broken trigger spring. (See BP and DP, above.)	Clean the trigger mechanism and replace broken parts if required.
FX	Failure to extract.	A broken or damaged extractor or extractor spring, or a sheared cartridge rim, will result in a failure to extract. On some occasions, particularly with a fouled chamber, the extractor may be forced over the rim of the case without causing a complete rim shear. A live round is often fed into the base of the case which failed to extract.	A sheared rim or broken extractor cannot be immediately cleared. A cleaning rod may be required to remove the fired case. When the cartridge rim is still intact and the extractor is undamaged, the fired case can usually be successfully extracted by manually cycling the the bolt, provided that the gun is first cleared of all live rounds. Inadvertent use of the bolt assist device as a first corrective action may cause a live round to be forced against the base of the fired case, firmly jamming the fired case in the chamber.

Abbreviation	Definition	Cause	Clearance
F2R	Firing two rounds on a single trigger pull in semiautomatic fire mode.	This malfunction is usually caused by the trigger pin moving out of position. (See also BP, DP, and FS, above.)	F2R cannot be overcome quickly; requires manipulation of the trigger and the trigger pin to correct. Disassembly of the gun is not necessary.
IP	Inoperative part. The part will not function as it was designed to. Usually refers to parts such as sight adjustment parts.	Most often it is caused by an accumulation of foreign matter — rust, corrosion, dirt — that is, a lack of proper maintenance. In various tests, exposure to dust, mud, or saltwater for extended periods without maintenance causes an IP.	Clean the part and replace it if necessary.
RC	Ruptured cartridge. A cartridge case has a circumferential rupture, leaving the upper part of the empty case in the forward part of the chamber. The base of the case (lower part) may or may not have been ejected from the receiver as in a failure to eject (FJ) malfunction.	This malfunction may be caused by the ammunition (a weak case) or the weapon initiating extraction too early in the operating cycle, when the gas pressure is still high in the bore and in the chambered empty case. This malfunction is extremely rare in the M16 system, but it was quite common in caliber .30 machine guns and the 7.62mm M73 machine gun.	Reduction of this stoppage often is time consuming. Sometimes it can be cleared by loading another round in the chamber (wedging the new round inside the forward part of the ruptured cartridge) and extracting and ejecting both the new round and the forward part of the ruptured cartridge. If that procedure does not work the cleaning rod must be used to attempt to dislodge the ruptured cartridge from the muzzle end of the weapon. Ruptured cartridge extractors (issue items for caliber .30 and 7.62mm systems) are not an item of issue for the 5.56mm weapons because this type of stoppage has been so rare. If the procedures listed above do not work, the weapon must be sent to ordnance for repair.

Abbreviation	Definition	Cause	Clearance
SR	Stubbed round.	The bolt moves forward, picking up the top round in the magazine and the tip of the round, instead of feeding into the chamber, comes in contact with the forward part of the magazine, the rear of the barrel extension, or the rear of the barrel, thus stopping the forward movement of the bolt. This stoppage occurs most frequently on the first round out of the magazine, but it can occur on any round. It is most often caused by a damaged magazine (lips are bent and do not control the round as the bolt attempts to strip it from the magazine), but can also be caused by a dented round.	It is usually relatively simple to clear the stoppage. Pulling the charging handle all the way to the rear and hold it there (or engage the bolt stop), then turn the rifle on its right side with the ejection port down (cover open), and the round will normally fall out of the receiver. (Occasionally the rifle must be shaken a little.) Striking the bolt assist will not normally clear the stoppage, nor will it complicate it. If the charging handle is pulled to the rear and released without removing the stubbed round, a double feed (DF) malfunction will result.

Tables Showing Detailed Malfunction Data, Quality Assurance Test Results, and Ammunition Lots Used in Tests

This inclosure contains 56 tables showing detailed malfunction data of the various tests and evaluations discussed in the basic appendix. The tables, grouped by time period, are listed below.

Prior to 1962: Tables 1-5.

The 1962-1963 Comparative Evaluation: Tables 6-8.

The 1963-1964 Period of Testing: Tables 9-19.

The 1965-1966 SAWS Study Cycle of Tests: Tables 20-34.

Tests Since the SAWS Study, 1967-1968: Tables 35-41.

Vietnam Malfunction Reports, 1967-1968: Table 42.

Panama Test, January 1968: Tables 43-48.

Colt Factory Reports, 1964-1968: Tables 49-56.

Inclosure 6-2

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TABLE 1 -- USAIB EVALUATION OF SMALL CALIBER HIGH VELOCITY RIFLES, ARMALITE (AR15)
PROJECT 2787, 27 MAY 1958

Test	Mode of Fire	Weapon	Rounds Fired	Malfunctions										Number per 1,000 Rounds
				COEC	FBC	FBR	FF	FFR	FJ	FX	SR	Other	Total	
Simulated combat conditions	Semi-Auto	AR15	2,916	20	6	11	112		7	21		2	179	61.4
		M14	1,586	14	123	6	28		12	51	2	17	253	159.5
	Auto	AR15	662	8	6	16	47			1		3	81	122.4
		M14	751	5	60	2	13			10		10	100	133.2
Adverse conditions														
5 days without cleaning		AR15	2,020			3	4	1	2				10	5.0
		M14	2,020										0	.0
Muddy water		AR15	40	5			10		5	14			34	850.0
		M14	41	6	15		14			1			36	878.0
Sand and dust		AR15	81	2					1	16			19	234.5
		M14	33	5	2		9		2	14			32	969.7
Artificial rain		AR15	200										0	.0
		M14	200		1					2			3	15.0
-25°F for 72 hrs		AR15	200				2						2	10.0
		M14	200										0	.0
125 F°for 72 hrs		AR15	200				1						1	5.0
		M14	200		25	1	12			10			48	240.0
Fired 100 rds at -25°F for 24 hrs		AR15	100										0	.0
		M14	100										0	.0
Total — all firings		AR15	6,419	35	12	30	176	1	15	52	0	5	326	50.8
		M14	5,131	30	226	9	76	0	14	88	2	27	472	92.0

Inclosure 6-2

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TABLE 2 — U.S. ARMY ARCTIC TEST BOARD EVALUATION OF SMALL CALIBER HIGH VELOCITY RIFLES, ARMALITE (AR15)
PROJECT 2787, 17 APRIL 1959

Test	Weapon	Rounds Fired	Malfunctions: BCS	BOB	BP	DF	DFP	FBC	FBR	FF	FFR	FJ	FJR	FTR	FX	IP	Other	Total[a]	Number per 1,000 Rounds
Adverse conditions:																			
Phase 1	AR15	300		3				1			1		3					8	26.7
	M14	300																0	.0
Phase 2	AR15	420											3			2		5	11.9
	M14	420									1						1	2	4.8
Phase 3	AR15	180			1						2							3	16.7
	M14	180									1							1	5.5
Phase 4	AR15	40					1	5	5	18	14				5			48	1200.0
	M14	40						12			3				2			17	425.0
Total — adverse conditions	AR15	940		3	1		1	6	5	18	17		6		5	2		64	68.1
	M14	940						12			5				2		1	20	21.3
All other firings: KD, transition, functional	AR15	18,766	53			1	4	1	2	32	36	47		58	25	4	10	273	14.5
	M14	9,600					2			4	1				3		1	11	1.2
Total — all firings	AR15	19,706	53	3	1	1	5	7	7	50	53	47	6	58	30	6	10	337	17.1
	M14	10,540					2	12		4	6				5		2	31	2.9

[a] Total does not include all malfunctions on either weapon. The number of times the M14 gas cylinder plug became loose and had to be tightened and the number of times the AR15 hammer retaining pin slipped out and had to be replaced were not recorded. Both weapons would have had a higher malfunction rate had those malfunctions been counted.

Inclosure 6-2

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TABLE 3— USATECOM (D&PS) TEST OF RIFLE, CALIBER .22, AR 15; RIFLE, LIGHTWEIGHT MILITARY, CALIBER .224; AND PERTINENT AMMUNITION, 3 FEBRUARY 1959, AND REPORT ON A TEST OF RIFLE, CALIBER .30, T44E6,[a] 27 JANUARY 1959

Test	Weapon	Rounds Fired	Malfunctions																	Number per 1,000 Rounds
			BCE	HOB	CHU	DF	FBC	FBR	FCB	FT	FT-)	FFR	FJ	FTR	FX	F7R	SR	Other	Total	
Miscellaneous: accuracy, flash and smoke, velocity, penetration, cook off	AR15	3,844		9				8		6	31							4	58	15.1
	M14	2,706										1	1						2	.7
Endurance: includes 1,000 rds acceptance tests	AR15	14,090		60		5	12	49		9	22	7	2	2	4	46	1	23	242	17.1
	M14	11,624					1			6		1	3				2		13	1.1
Adverse conditions: unlubricated, extreme cold, dust, mud, rain	AR15	2,176	4	39	2		24	1	3	17	2	57	11	19		1	3		183	84.1
	M14	1,526					3			54		2	6						65	42.6
Total — all tests	AR15	20,110	4	108	2	5	36	58	3	32	55	64	13	21	4	47	4	27	483	24.0
	M14	15,856					4			60		4	10				2		80	5.0

[a] The T44E6 was a lightweight M14. The test report stated that the T44E6 was somewhat less reliable than the T44E4, which became the M14.

Inclosure 6-2

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TABLE 4 — U.S. ARMY COMBAT DEVELOPMENT EXPERIMENTATION CENTER REPORT ON A RIFLE SQUAD ARMED WITH A LIGHTWEIGHT HIGH VELOCITY RIFLE, 30 MAY 1959

Experiment	Weapon	Rounds Fired	Malfunction										Number per 1,000 Rounds
			BP	DF	FBC	FF	FFR	FJ	FTR	FX	Other	Total	
Daylight attack	AR15	10,075			12	8		9			5	34	3.4
	M14	9,537	3		8	6		11			4	32	3.4
Daylight defense	AR15	12,671		1	4	7	3	12	2	4	2	35	2.8
	M14	12,778			3	3		1				7	.5
Total	AR15	22,746		1	16	15	3	21	2	4	7	69	3.0
	M14	22,315	3		11	9		12			4	39	1.7

Inclosure 6-2

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TABLE 5 — USATECOM (D&PS) A TEST OF RIFLE, CALIBER .223, AR15, REPORT DPS-96, OCTOBER 1960

Test	Weapon	No.	Rounds Fired	Malfunctions											Number per 1,000 Rounds
				BCE	CHU	FBC	FBR	FF	FFR	FJ	FTR	FX	F2R	Total	
Accuracy	AR15	614	944			1								1	1.0
	AR15	645	296											0	.0
	AR15	682	901			1								1	1.1
	AR15	689	199											0	.0
	AR15	835	887											0	.0
Subtotal	AR15		3,227			2								2	.6
Endurance	AR15	614	6,097	4		3	3	1	2			1		14	2.3
	AR15	682	6,089	11		2	3	5	3			1		25	4.1
	AR15	835	6,090	1	1				5					7	1.1
Subtotal	AR15		18,276	16	1	5	6	6	10			2		46	2.5
Adverse conditions:															
extreme cold, un-	AR15	614	1,080			4	5	3	1	1				14	13.0
lubricated, dust,	AR15	682	940			5	1	3	1		12	1		23	24.5
mud, rain, cook off	AR15	835	920			14	12	6					1	33	35.9
Subtotal	AR15		2,940			23	18	12	2	1	12	1	1	70	23.8
Total — all tests	AR15		24,443	1[illegible]	1	30	24	18	12	1	12	3	1	118	4.8

Inclosure 6-2

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TABLE 6 — U.S. ARMY INFANTRY SCHOOL RIFLE EVALUATION, 20 DECEMBER 1962

Test	Weapon	Rounds Fired	Malfunctions									Number per 1,000 Rounds
			BP	DF	FBC	FF	FJ	FX	RC	Other	Total	
All firings	AR15	35,196		2	1	48	3	9	2	0	65	1.8
	M14a/	58,157	2			15		1		0	18	.3

a Includes both the modified M14 and the USAIB M14.

Inclosure 6-2

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TABLE 7 — USAIB REPORT OF PROJECT 3008, COMPARATIVE EVALUATION OF AR15 (ARMALITE) AND M14 RIFLES, 7 DECEMBER 1962

Test	Weapon	Rounds Fired	Malfunctions									Number per 1,000 Rounds
			BP	DFP	DP	FBR	FF	FX	IP	Other	Total	
All tests	AR15	43,600		1		48	179	1	3	16	248	5.7
	M14	89,300	1		1	13	9	1			25	.3

Inclosure 6-2

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TABLE 8 — DEVELOPMENT AND PROOF SERVICE REPORT ON COMPARATIVE EVALUATION OF AR 15 AND M14 RIFLES REPORT D&PS-799, 5 DECEMBER 1962

Test	Weapon	Rounds Fired	Malfunctions													Number per 1,000 Rounds	
			BOB	BP	FBC	FBR	FCB	FF	FFR	FJ	FX	IP	SR	Other	Total		
Miscellaneous: velocity, accuracy, flash and smoke, sound, cook off	AR15	4,732	1	1	9	13		49						1	74a/	15.6	(8.7)b/
	M14	5,485	6			1		5		3			22	1	38	6.9	
Adverse conditions: unlubricated, extreme cold, dust, mud, rain	AR15	2,340				17		20	71	37	4				149c/	63.7	(37.6)d/
	M14	3,097						22	11	3		26			62	20.0	
Sustained fire	AR15	567			1	20	6	2							29	51.1	
	M14	537								1					1e/	1.9	
Totals — all tests	AR15	7,639	1	1	10	50	6	71	71	37	4			1	252f/	33.0	(20.7)g/
	M14	9,119	6			1		27	11	7		26	22	1	100	11.0	

a Includes 33 failures to feed (FF) caused by a missing gas tube pin on one rifle (should have been detected by test personnel before firing).
b Malfunction rate excluding the 33 FF's (see a, above).
c Includes 61 failures to fire (FFR) caused by 61 dislodged primers (faulty ammunition).
d Malfunction rate excluding the 61 FFR's (see c, above).
e The M14 ruptured the barrel on the 473d round of the 500-round sustained fire test.
f Total malfunctions excluding the 33 FF's (see a, above) and the 61 FFR's (see c, above) would be 158.
g Malfunction rate excluding the 33 FF's and 61 FFR's (see a and c, above).

Inclosure 6-2

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TABLE 9 — SPRINGFIELD ARMORY TEST REPORT ENGINEERING EVALUATION
AR15 RIFLE, 21 MARCH 1963

Performance test	Weapon	Rounds Fired	Malfunctions							Number per 1,000 Rounds
			BOB	FBR	FF	FFR	FX	SR	Total	
Rifle 7465	AR15	505		1	3	6		3	13	25.7
Rifle 7570	AR15	310	2	1					3	9.8
Rifle 7915	AR15	1,234	3	2	2		1		8	6.5
Rifle 8168	AR15	605	2		4			1	7	11.6
Rifle 8276	AR15	417	2	2	2				6	14.4
Rifle 8357	AR15	665	1	1	5			3	10	15.0
Total		3,736	10	7	16	6	1	7	47	12.6

Inclosure 6-2

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TABLE 10 — U.S. MARINE CORPS COMPARATIVE EVALUATION OF M14 RIFLE AND AR15 RIFLE, FEBRUARY - MARCH 1963

Evaluation	Weapon	Rounds Fired	Malfunctions									Number per 1,000 Rounds
			FBC	FBR	FF	FFR	FJ	FX	FS	Other[a]	Total	
Phase A	AR15	50,800		380	322	26	1	46		34	809	15.9
	M14	47,800		2	40	35	3	21		1	102	2.1
Phase B	AR15	49,300	3	101	87	3		2	7	120	323	6.7
	M14	46,600		4	108	12	3	60		2	189	4.1
Subtotal	AR15	100,100	3	481	409	29	1	48	7	154	1,132	11.3
	M14	94,400		6	148	47	6	81		3	291	3.1
Phase C	AR15	50,500		22	7	8	1	4		17	59	1.2
	M14	46,800		2	49	69	7	129		2	258	5.5
Parris Island	AR15	4,200	1	1	5			1	3	1	12	2.9
	M14	4,200								1	1	.2
Subtotal	AR15	54,700	1	23	12	8	1	5	3	18	71	1.3
	M14	51,000		2	49	69	[illegible]	129		3	259	5.1
Total	AR15	154,800	4	504	421	37	2	53	10	172	1,203	7.8
	M14	145,400		8	197	116	13	210		6	550	3.8

a Other malfunctions consist here of defective magazines and defective ammunition. The AR15 had 140 defective magazines and 32 defective rounds; the M14 had 3 defective magazines and 3 defective rounds.

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TABLE 11 — U.S. ARMY TEST EVALUATION COMMAND (D&PS) REPORT ON EVALUATION TEST OF THE RATE OF TWIST IN CALIBER .223, RIFLE, AR15, APRIL 1963

Weapon Number	Weapon	Rounds Fired	Malfunctions										Number per 1,000 Rounds
			BOB	BP	CDCEC	FBR	FF-1	FFR	FJ	FJR	SR	Total	
8825	AR15	6,465	2	1		98	50					151	23.4
8833	AR15	6,465		1		86	7		1			95	14.7
11285	AR15	6,460	5	1		2	13	1				22	3.4
11705	AR15	6,460	1	2	1	30	93			3	31	161	24.9
894613	M14	6,622	1	7	1						7	16	2.4
Total	AR15	25,850	8	5	1	216	163	1	1	3	31	429	16.6
	M14	6,622	1	7	1						7	16	2.4

Inclosure 6-2

TABLE 12 — USAIB REPORT OF PRODUCT IMPROVEMENT TEST OF ARMALITE AR15 RIFLE (TEST OF BOLT ASSIST DEVICE) 30 AUGUST 1963

Exercises	Weapon	Rounds Fired	Malfunctions						Number per 1,000 Rounds
			FBC	FBR	FF	FF-1	FX	Total	
I	AR15	(1,200)[a]		1	3	3		7	(5.8)[b]
II	AR15	(600)		5	2			7	(11.7)
III	AR15	(600)	1		2	3	4	10	(16.7)
IV	AR15	(600)			1	4	2	7	(11.7)
Total		2,886[c]	1	6	8	10	6	31	10.7[d]

a Numbers in parenthesis indicate rounds scheduled to be fired in each exercise (actual number fired was not stated).
b Rates in parenthesis indicate what the malfunction rate would be if all scheduled rounds were fired.
c Actual total number of rounds fired for all exercises.
d Actual malfunction rate for all exercises.

Inclosure 6-2

TABLE 13 -- USAIB SECOND LETTER REPORT OF TEST RESULTS PRODUCT IMPROVEMENT TEST OF ARMALITE AR15 RIFLE (TEST OF BOLT ASSIST DEVICE), 14 OCTOBER 1963

Exercise	Weapon	Rounds Fired	Malfunctions					Number per 1,000 Rounds
			FBR	FF	FF-1	FX	Total	
I	AR15	(800)a/		1	2	2	5	(6.3)b/
II	AR15	(800)	3	1	6		10	(12.5)
III	AR15	(800)	1	2	6	4	13	(16.3)
Total		2,465c/	4	4	14	6	28	11.4d/

a Numbers in parenthesis indicate the number of rounds scheduled to be fired in each exercise (actual number fired was not stated).
b Rates in parenthesis indicate what the malfunction rate would be if all scheduled rounds were fired.
c Actual total number of rounds fired in all exercises.
d Actual malfunction rate for all exercises.

Inclosure 6-2

TABLE 14 — USATECOM REPORT ON PRODUCT IMPROVEMENT TEST OF BOLT ASSIST DEVICES FOR RIFLE, CALIBER .223, AR15, REPORT DPS-1120, NOVEMBER 1963

Test	Weapon[a]	Rounds Fired	Malfunctions										Number per 1,000 Rounds
			BOB	FBC	FBR	FF	FFR	FJ	FX	SR	Other	Total	
Unlubricated	C	180										0	.0
	P	120				2						2	16.7
Dust	C	180	1	3	3	12		1	2			22	122.2
	P	120	2	1	1	20			1			25	208.3
Mud	C	180	2	39		12	5	19	127			204	1,133.3
	P	120		70		7			116		23	216	1,800.0
Cold (-65)	C	1,800	9	9	1	18		43	1		2	83	46.1
	P	1,200	10	11	3	35	4	1	1			65	54.2
Cook off	C	797	1		24					4		29	36.4
Total	C	3,137	13	51	28	42	5	63	130	4	2	338	107.7
	P	1,560	12	82	4	64	4	1	118		23	308	197.4
	Both	4,697	25	133	32	106	9	64	248	4	25	646	137.5

[a] Weapon code: C = AR15 with modified charging handle bolt assist device; P = AR15 with side mounted plunger bolt assist device.

TABLE 15 — USAIB LETTER REPORT OF PRODUCT IMPROVEMENT TEST OF XM16 RIFLES 4 DECEMBER 1963

Test	Weapon	Rounds Fired	Malfunctions							Number per 1,000 Rounds
			DF	FBC	FBR	FF	FFR	FF-1	Total	
I	XM16	3,600		2					2	.6
II	XM16	1,800	2	3	1	10		1	17	9.4
III	XM16	1,800	1	4		5	1		11	6.1
Total		7,200	3	9	1	15	1	1	30	4.2

Inclosure 6-2

TABLE 16 -- U.S. AIR FORCE MARKSMANSHIP SCHOOL - EVALUATION OF M16 MODIFICATION FIRING PIN RETAINING DEVICES, 6 DECEMBER 1963

Weapon	Number	Rounds Fired	Malfunctions										Number per 1,000 Rounds
			BP	DFP	DF	FBR	FF	FF-1	FX	IP	SR	Total	
M16	021321	7,787	5			1	3					9	1.2
M16	021552	7,000	6		2	2	3		2		1	16	2.3
M16	023336	7,320	2		1	1		3			1	8	1.1
M16	023354	7,000	1	1		1		2	1	1		7	1.0
M16	023349	6,778	2			3	1	1	1			8	1.2
Total		35,885	16	1	3	8	7	6	4	1	2	48	1.3

TABLE 17 — USATECOM (D&PS) ENGINEER DESIGN TEST OF ALTERNATE PROPELLANTS FOR USE IN CARTRIDGE 5.56MM, BALL, M193, APRIL 1964

		Rounds	Malfunctions						Number per
Ammo Lot - Weapon Number	Weapon	Fired	BOB	BP	FF	FFR	FJ	Total	1,000 Rounds
Lot RA 223-103 (WC846)									
031857	AR15	1,874						0	.0
032052	AR15	6,000	1	3		1	5	10	1.7
032852	AR15	6,000	1	2			1	4	.7
Subtotal		13,874	2	5		1	6	14	1.0
Lot RA 223-104 (HPC 10)									
033042	AR15	1,840			1			1	.5
033278	AR15	6,000						0	.0
034665	AR15	6,000		1				1	.2
Subtotal		13,840		1	1			2	.1
Lot RA 223-105 (IMR 4475)									
034729	AR15	1,770						0	.0
034769	AR15	6,000		1				1	.2
034777	AR15	6,000		1				1	.2
Subtotal		13,770		2				2	.1
Lot RA 223-106 (EX8136-1)									
034787	AR15	1,790						0	.0
034973	AR15	6,000	1		19			20	3.3
035204	AR15	6,000						0	.0
Subtotal		13,790	1		19			20	1.5
Total		55,274	3	8	20	1	6	38	.7

Inclosure 6-2

TABLE 18 -- USATECOM (D&PS) REPORT ON PRODUCT IMPROVEMENT TEST OF MODIFIED AR15 RIFLES
REPORT DPS-1276, APRIL 1964

Test	Weapon	Rounds Fired	Malfunctions														Number per 1,000 Rounds
			BCE	BOB	BF	DF	FBC	FBR	FF	FF-1	FFR	FJ	FX	SR	DFP	Total	
Extreme cold (-65°)	AR15	560		3			1			1	1					6	10.7
Extreme heat (+125°)	AR15	560		1						1				1		3	5.4
Rain	AR15	3,000	21				7	10		2						40	13.3
Dust	AR15	100														0	.0
Mud	AR15	134		17		1	78	1	1			70				168	1,253.7
Endurance	AR15	29,119	149	13	11	16	149	35	49	154		5	6	34	5	626	21.5
Total		33,473	170	34	11	17	235	46	50	158	1	75	6	35	5	843	25.2

Inclosure 6-2

TABLE 19 — USATECOM (D&PS) FINAL REPORT OF COMPARISON TEST OF RIFLE, 5.56MM, M16, REPORT DPS-1471, OCTOBER 1964

Test	Weapon	Rounds Fired	Malfunctions									Number per 1,000 Rounds
			BCE	FBC	FBR	FF	FFR	F2R	FX	SR	Total	
Adverse conditions												
Unlubricated	M16	100									0	.0
Dust	M16	20									0	.0
Mud	M16	20									0	.0
Rain	M16	600					13				13	21.7
Extreme cold	M16	620		7					20[a]		27	43.5
Heat and humidity	M16	160									0	.0
Subtotal		1,520		7			13		20		40	26.3
Reliability: accuracy, and rate-of-aimed-fire	M16	16,812	6	3	1	3	1	5		4	23	1.4
Total - all tests	M16	18,332	6	10	1	3	14	5	20	4	63	3.4

a The 20 failures to extract were caused by a defective extractor and spring (when replaced, no further extraction problems wer perienced).

Inclosure 6-2

TABLE 20 — USATECOM (D&PS) FINAL REPORT OF COMPARISON TEST OF RIFLE, 5.56MM, XM16E1
(8 SEP - 13 NOV 64) JANUARY 1965

Test	Weapon	Rounds Fired	Malfunctions									Number per 1,000 Rounds
			BCE	BOB	FBC	FRB	FFR	FF1	FJ	SR	Total	
Adverse conditions												
Unlubricated	XM16E1	100			1						1	10.0
Dust	XM16E1	20									0	.0
Mud	XM16E1	20									0	.0
Rain	XM16E1	600					3		2	1	6	10.0
Extreme cold (-65°)	XM16E1	320			2						2	6.3
Heat and humidity	XM16E1	160									0	.0
Subtotal	XM16E1	1,220			3		3		2	1	9	7.4
Reliability, including accuracy	XM16E1	15,089	2		1	3		6	4	5	21	1.4
Repair parts interchange	XM16E1	120		1							1	8.3
Total	XM16E1	16,429	2	1	4	3	3	6	6	6	31	1.9

Inclosure 6-2

TABLE 21 — USATECOM (D&PS) FINAL REPORT OF ENGINEERING TEST OF CARTRIDGE, 5.56MM, TRACER XM196 REPORT DPS-1687 (15 JULY 1964 - 16 MARCH 1965), JUNE 1965

Weapon	Number	Rounds Fired	Malfunctions								Number per 1,000 Rounds
			DF	FCB	FF	FFR	F2R	FX	BP	Total	
M16	8625	140								0	.0
XM16E1	23295	220								0	.0
XM16E1	23348	120								0	.0
M16	7239	7,185	3			13				16	2.2
M16	7721	6,300	3		3	30	89	1	1	127[a]	20.2
M16	8651	6,976	2	1		1				4	.6
Total		20,941	8	1	3	44	89	1	1	147	7.0

a This figure represents 86 percent of all malfunctions. Of the 86 percent, 60 percent (89) were firing two rounds on one pull of the trigger (F2R) and another 20 percent (30) were failures to fire (FFR).

Inclosure 6-2

TABLE 22 — USATECOM (USAIB) FINAL REPORT OF SAWS SERVICE TEST, USAIB PROJECT 3110, DECEMBER 1965

Weapon	Rounds Fired	Malfunctions														Number per 1,000 Rounds
		BCS	BOB	BP	DF	DP	FBC	FBR	FF	FFR	FJ	FX	IP	Other	Total	
XM16E1	95,720	2	188	23	33	31	3	532	75	39	251	86	1	5	1,269	13.3
M14	445,268	1	11	24	4	12	34	6	200	16	19	18		6	351	.8

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TABLE 23 — BARREL EROSION STUDY OF RIFLES, 5.56MM, M16, AND M16E1, REPORT SA-TR1[illegible]-5000, JANUARY 1966

XM16E1	Number	Rounds Fired	Malfunctions[a]													Number per 1,000 Rounds[a]
			BCS	BOB	BUB	DF	FBC	FBR	FF	FFR	FJ	FS	FX	Other	Total	
Std	118603	35,000	45		1			126	25	12	209	1		1	420	12.0
Std	122033	29,000	25	1	3		5	105	8	12	71				230	7.9
Std	113821	35,000	74		1			677	44	18	140			3	957	27.3
Std	122994	30,000	13				1	86	18	13	191		4		326	10.9
Std	121654	22,000						98	2	21	153				274	12.5
Std	121185	21,000	6					163	4	18	85		8		284	13.5
Subtotal		172,000	163	1	5		6	1,255	101	94	849	1	12	4	2,491	14.5
Mod	108860	27,000	24				1	67	19	51	173		1		336	12.4
Mod	123226	35,000	11					200	10	34	282				537	15.3
Mod	109068	27,000	16	3		10	1	86	40	27	301		10		494	18.3
Mod	105083	19,000	11			1	1	70	17	10	134		3		247	13.0
Mod	109085	25,000			1			44	2	9	89		3		148	5.9
Mod	122429	23,000	1			6	2	76	2	5	171	2	6		271	11.8
Subtotal		156,000	63	3	1	17	5	543	90	136	1,150	2	23		2,033	13.0
Total — all weapons		328,000	226	4	6	17	11	1,798	191	230	1,999	3	35	4	4,524	13.8

[a]See Tables 24 and 25 for malfunctions and rates for the first 6,000 and 10,000 rounds, respectively, of this test.

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TABLE 24 — BARREL EROSION STUDY OF RIFLES, 5.56MM, M16 AND M16E1, REPORT SA-TR11-5000, JANUARY 1966 (First 6,000 Rounds)[a]

XM16E1	Number	Rounds[b] Fired	Malfunctions[b] FBC	FBR	FF	FFR	FJ	FX	Total	Number per 1,000 Rounds	Percentage of Total Malfunctions
Std	118603	6,198		33	2	1	9		45	7.3	10.7
Std	122033	6,140		48			9		57	9.3	24.7
Std	113821	6,762		133	1	3	18		155	22.9	16.1
Std	122994	6,040		66		3	64		133	22.0	40.7
Std	121654	6,191		60			91		151	24.4	55.1
Std	121185	6,296		90	1	1	17	1	110	17.5	38.7
Subtotal		37,627		430	4	8	208	1	651	17.3	26.1
Mod	108860	6,719	1		3	4	11		19	2.8	5.6
Mod	123226	6,200		3	1		11		15	2.4	2.7
Mod	109068	6,145		4	4	2	25		35	5.7	7.0
Mod	105083	6,007		9	4	6	4		23	3.8	9.3
Mod	109085	6,000		15		2	12		29	4.8	19.5
Mod	122429	6,132		6		3	5		14	2.3	5.1
Subtotal		37,203	1	37	12	17	68		135	3.6	6.6
Total — all weapons		74,830	1	467	16	25	276	1	786	10.5	17.3

a Malfunctions and rates for the first 6,000 rounds (approximately). Can be compared with 6,000-round endurance test results of other tests.

b See Table 23 for total rounds fired and total malfunctions experienced.

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TABLE 25 — BARREL EROSION STUDY OF RIFLES, 5.56MM, M16 AND XM16E1, REPORT SA-TR11-5000, JANUARY 1966 (First 10,000 Rounds)[a]

XM16E1	Number	Rounds[b] Fired	Malfunctions[b] BCS	DF	FBC	FBR	FF	FFR	FJ	FX	Other	Total	Number per 1,000 Rounds	Percentage of Total Malfunctions
Std	118603	10,876				40	3	2	27		1	73	6.7	17.3
Std	122033	10,118	1			52			28			81	8.0	35.2
Std	113821	10,241	5			133	5	5	29			177	17.3	18.4
Std	122994	10,128	7			73	2	3	77			162	16.0	49.6
Std	121654	10,255				80			100			180	17.6	65.6
Std	121185	10,000				142	2	1	19	8		172	17.2	60.5
Subtotal		61,618	13			520	12	11	280	8	1	845	13.7	33.9
Mod	108860	10,067	1		1	1	7	4	13			27	2.7	8.0
Mod	123226	10,600				13	2		11			26	2.5	4.8
Mod	109068	10,012	9	3		37	5	8	59			121	12.1	24.4
Mod	105083	10,000	8	1	1	33	9	6	19	2		79	7.9	31.9
Mod	109085	14,472				30		4	25	1		60	4.1	40.5
Mod	122429	10,000		3		40		4	92			139	13.9	51.2
Subtotal		65,151	18	7	2	154	23	26	219	3		452	6.9	22.2
Total — all weapons		126,769	31	7	2	674	35	37	499	11	1	1,297	10.2	28.6

[a] Malfunctions and rates for the first 10,000 rounds (approximately). Can be compared with results of other tests firing the same number of rounds.

[b] See Table 23 for total rounds fired and total malfunctions experienced.

Inclosure 6 2

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TABLE 26 — A TEST OF CARTRIDGE, 5.56MM, BALL, M193, LOTS RA 5074 AND WCC 6089 IN RIFLES 5.56 MM, XM16E1, AND AR15, FEBRUARY 1966

Rifle		Rounds Fired	Malfunctions												Number per 1,000 Rounds
			BCS	BOB	BUB	CHU	DF	FBC	FBR	FF	FFR	FJ	FX	Total	
XM16E1	140814[a]	12,000		1		3		2	14		2	1		23	1.9
XM16E1	139319[b]	12,000	3	2		37		5	60	5	21	13	2	148	12.3
XM16E1	140595[c]	12,000		1		54		3	104	1	5	3	1	172	14.3
XM16E1	139426[c]	12,000	1	35		8	1	3	98	9	2	16	3	176	14.7
AR15	34787[a]	12,000		4					81	1	4		1	91	7.6
AR15	31857[b]	12,000	14	1	1			10	122	3	62	4	1	218	18.2
Subtotal[a]		24,000		5		3		2	95	1	6	1	1	114	4.8
Subtotal[b]		24,000	17	3	1	37		15	182	8	83	17	3	366	15.3
Subtotal[c]		24,000	1	36		62	1	6	202	10	7	19	4	348	14.5
Total — all firings		72,000	18	44	1	102	1	23	479	19	96	37	8	828	11.5

a Fired Lot RA 5074 (IMR propellant) only.
b Fired Lot WCC 6089 (ball propellant) only.
c Fired both lots, alternating every 3,000 rounds.

Inclosure 6-2

TABLE 27 -- A TEST OF CARTRIDGE, 5.56MM, BALL, M193, LOTS RA 5074 AND WCC 6089 IN RIFLES 5.56MM, XM16E1, AND AR15, FEBRUARY 1966 (First 6,000 Rounds)

Weapon	Number	Rounds Fired	Malfunctions										Number per 1,000 Rounds	Percentage of Total Malfunctions[d]
			BCS	BOB	CHU	FBC	FBR	FF	FFR	FJ	FX	Total		
XM16E1	140814[a]	6,000		1			5					6	1.0	26.0
XM16E1	139319[b]	6,000	2	1	8	1	34		2	2		50	8.3	33.7
XM16E1	140595[c]	6,000		1	21	2	28			1	1	54	9.0	31.3
XM16E1	139426[c]	6,000		21	2	1	50	7	1	2	3	87	14.5	49.4
AR15	31857[a]	6,000		2			43	1				46	7.7	50.5
AR15	31857[b]	6,000		1		6	121	1	2			131	21.8	60.0
Subtotal[a]		12,000		3			48	1				52	4.3	45.6
Subtotal[b]		12,000	2	2	8	7	155	1	4	2		181	15.1	49.4
Subtotal[c]		12,000		22	23	3	78	7	1	3	4	141	11.8	40.5
Total — all firings		36,000	2	27	31	10	281	9	5	5	4	374	10.4	45.1

a Fired Lot RA 5074 (IMR propellant) only.
b Fired Lot WCC 6089 (ball propellant) only.
c Fired both lots, alternating every 3,000 rounds.
d Total malfunctions for the entire 12,000-round test are at Table 26.

Inclosure 6-2

TABLE 28 — A TEST OF CARTRIDGE, 5.56MM, BALL, M193, LOTS RA 5074 AND WCC 6089, IN RIFLES, 5.56MM, XM16E1, AND AR15, FEBRUARY 1966 (First 10,000 Rounds)

Rifle	Number	Rounds Fired	Malfunctions										Number per 1,000 Rounds	Percentage of Total Malfunctions[d]
			BCS	BOB	CHU	FBC	FBR	FF	FFR	FJ	FX	Total		
XM16E1	140814[a]	10,000		1	1	2	11		1	1		17	1.7	73.9
XM16E1	139319[b]	10,000	2	1	29	4	59	1	4	13	2	115	11.5	77.7
XM16E1	140595[c]	10,000		1	38	3	102	1	5	3	1	154	15.4	89.5
XM16E1	139426[c]	10,000		28	3	2	75	7	2	3	3	123	12.3	69.8
AR15	34787[a]	10,000		3			66	1			1	71	7.1	78.0
AR15	31857[b]	10,000	11	1		10	122	3	26	3	1	177	17.7	81.1
Subtotal[a]		20,000		4	1	2	77	1	1	1	1	88	4.4	77.1
Subtotal[b]		20,000	13	2	29	14	181	4	30	16	3	292	14.6	79.7
Subtotal[c]		20,000		29	41	5	177	8	7	6	4	277	13.9	79.5
Total — all firings		60,000	13	35	71	21	435	13	38	23	8	657	11.0	79.3

a Fired Lot RA 5074 (IMR propellant) only.
b Fired Lot WCC 6089 (ball propellant) only.
c Fired both Lots, alternating every 3,000 rounds.
d Total malfunction for the entire 12,000-round test are at Table 26.

Inclosure 6-2

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TABLE 29 — USATECOM (D&PS) ENGINEERING TEST OF SAWS, VOLUME I, PARTIAL REPORT (DPS-1851), DECEMBER 1965, AND VOLUME I, FINAL REPORT (DPS-1970) MARCH 1966

Test	Weapon	Rounds Fired	Malfunctions																				Total	Number per 1,000 Rounds
			BCE	BCS	BOB	BP	BUB	CHU	DFP	DP	FBC	FBR	FCB	FF	FFR	FJ	FJR	FS	FTR	FX	F2R	IP	Other		
Miscellaneous: accuracy, dispersion, safety, smoke and flash	XM16E1	3,319					1	1				43		8	8	17								78	23.5
	M14	7,625												1	1					3	4		2	11	1.4
Adverse Conditions: High temperature (+155°)	XM16E1	2,400						3			2	24			13	24								66	27.5
	M14	4,800									1			5							1		2	9	1.9
Low temperature (-65°)	XM16E1	6,000									28			118	29	75		1	2					253	42.2
	M14	12,000				1					1	1		7									2	12	1.0
Unlubricated	XM16E1	4,000	1	2		1		2		2		25		1	1	57								92	23.0
	M14	7,810			7	2					5	4		50	2			268	8	14				360	46.1
Sand	XM16E1	200														13								13	65.0
	M14	400									19	1		51		25								96	240.0
Salt water	XM16E1	200														8								8	40.0
	M14	400									4													4	10.0
Humidity	XM16E1	200										4				4								8	40.0
	M14	400														1								1	2.5
Water spray (rain test)	XM16E1	1,200									4			2		31								37	30.8
	M14	2,400												46	1	1								48	20.0

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 29 — continued

Test	Weapon	Rounds Fired	Malfunctions																						Number per 1,000 Rounds
			BCE	BCS	BOB	BP	BUB	CHB	DFP	DP	FBC	FBR	FCL	FF	FTR	FJ	FJR	FS	FTR	FX	F2R	IP	Other	Total	
Dust	XM16E1	40										1				5								6	150.0
	M14	80									15			28	1	2								46	575.0
Mud	XM16E1	40												3		2								5	125.0
	M14	80									55	3		46		23								127	1,587.5a/
Subtotal Adverse Conditions	XM16E1	14,280	1	2		1		5		2	34	54		124	43	219		1	2					488	34.2
	M14	28,370			7	3					100	9		233	4	52		268	8	14	1		4	703	24.8
Reliability (first 6,000 rounds)	XM16E1	18,325		1	16	2	3	55		2	3	180		16	133	359								770	42.0
	M14	38,239			11	6								42	10		1					4	4	78	2.0
Total — end of 12,000-round test	XM16E1	32,975		1	29	5	3	86		2	3	408		30	143	462							1	1,173	35.6
	M14	70,344		3	44	14				1	6	3		108	13	7	1			1	2	4	4	211	3.0
Sustained fire	XM16E1	9,271		1	67	3		22	7			264	2	8	19	57				8				458	49.4
	M14	20,055			54		1			20	1	1		43	1		3	4		5		2	4	139	6.9
Total — all tests	XM16E1	59,845	1	4	96	9	4	114	7	4	37	769	2	170	213	755		1	2	8			1	2,197	36.7
	M14	146,394		3	105	17	1			21	107	13		385	19	59	4	272	8	23	7	6	14	1,064	7.3

a/Malfunctions in excess of one per round fired are not uncommon in adverse conditions tests. For example: a failure to feed, a failure to extract, a failure of the bolt to remain to the rear, and a broken part could occur in firing one round.

2

Inclosure 6-2

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TABLE 30 — USACDCEC SMALL ARMS WEAPONS SYSTEMS (SAWS)
FIELD EXPERIMENT, 10 MAY 1966

Phase	Weapon	Rounds Fired	Malfunctions												Number per 1,000 Rounds
			BCS	BOB	BUB	DF	FP	FBR	FF	FFR	FJ	FX	Other	Total	
Training	XM16E1	105,313				80		59	88	4	120	3	4	358	3.4
	M14	156,589					4	2	4	1		1	4	16	.1
Exploratory firing	XM16E1	66,822		56		24		169	33	53	94	27	1	457	6.8
	M14	47,889							11	9	1	1		22	.5
Field experiment	MX16E1	265,557	4	119		267	28	98	292	410	1,030	222	6	2,476	9.3
	M14	116,049	1	5	2		7		74	69	3	3		164	1.4
Total — all phases	XM16E1	437,692	4	175		371	28	326	413	467	1,244	252	11	3,291	7.5
	M14	320,527	1	5	2		11	2	89	79	4	5	4	202	.6
Special, fouling test	XM16E1[a]	5,000		3		2		6	3	4	6	4		28	5.6
	XM16E1[b]	7,620		2					4	1				7	.9

[a] Fired with 5.56mm, M193, ball ammunition loaded with WC 846 (ball) propellant, Lot WCC 6098 (used in all phases of the field experiment).

[b] Fired with 5.56mm, M193, ball ammunition loaded with IMR (CR 8136) propellant, Lot RA 5074.

Inclosure 6-2

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TABLE 31 — SPRINGFIELD ARMORY EVALUATION OF PROPOSED BUFFER DESIGNS
13 MAY 1966

Test	Buffer	Ammo	Rounds Fired Propellant Ball	IMR	Malfunctions BCS	BOB	CDEC	FBC	FBR	FF	FFR	FJ	FS	FX	SR	Total	Number per 1,000 Rounds Ball	IMR
-65°	1a/	Ball	3,700		1	5			1			5				12	3.2	
				3,000		14	5	5	9	2	1	5				41		13.7
		Tracer		2,300		2			3							5		2.2
-65°	2	Ball	2,500			2			11		1					14	5.6	
				2,700		21	5	9	3							38		14.1
		Tracer		3,500		2						1				3		.9
-65°	3	Ball	3,000		2	5		1	7		2					17	5.7	
				3,000		7	4	1	4		1				3	20		6.7
		Tracer	1,300			4			1						2	7	5.4	
				1,000												0		.0
-65°	4a/	Ball	3,000			3			38						1	42	14.0	
				3,000		2			2		5				1	10		3.3
-65°		Tracer	1,000			2										2	2.0	
				2,000		2										2		1.0
+155°	2	Ball	3,000			66		7	23			1				97	32.3	
				3,000		3							1			4		1.3

a Test buffers 1 and 4 were withdrawn from the test after the -65° firings.

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TABLE 31 — continued

Test	Buffer	Ammo	Rounds Fired Propellant Ball	IMR	Malfunctions BCS	BOB	CDEC	FBC	FBR	FF	FFR	FJ	FS	FX	SR	Total	Number per 1,000 Rounds Ball	IMR
+155°	3	Ball	3,000			31		9	41			6				87	29.0	
				3,000		3								1		4		1.3
	Std	Ball	6,000			90		9	209		38	71		1		418	69.7	
Ambient	2	Ball	2,040			17		1	13							31	15.2	
				1,800		1			6							7		3.9
	3	Ball	1,200			9			28			1			1	39	32.5	
				1,800					3						2	5		2.8
	Std	Ball	3,600			59		4	107		60	51				281	78.1	
				4,220		5			5						2	12		2.8
Subtotal	2	Ball	7,540			85		8	47		1	1				142	18.8	
				7,500		25	5	9	9				1			49		6.5
		Tracer		3,500		2						1				3		.9
	3	Ball	7,200		2	45		10	76		2	7			1	143	19.9	
				7,800		10	4	1	7		1			1	5	29		3.7
		Tracer	1,300			4			1						2	7	5.4	
				1,000												0		.0
	Std	Ball	9,600			149		13	316		98	122		1		699	72.8	
				4,200		5			5						2	12		2.8
Total — all tests		Ball	31,040		3	287		31	478		101	135		1	2	1,038	33.4	
				25,520		56	14	15	32	2	7	5	1	1	8	141		5.5
		Tracer	2,300			6			1						2	9	3.9	
				8,800		6			3			1				10		1.1

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TABLE 32 — USATECOM ENGINEER DESIGN TEST OF CARTRIDGE, 5.56MM, BALL, M193 (EVALUATION OF IMPROVED AND/OR ALTERNATE PROPELLANTS) 25 January - 19 May 1966

Test/Propellant	Number of Weapons	Rounds Fired	Malfunctions									Number per 1,000 Rounds
			BCS	BOB	CHU	COEC	FBR	FF	FFR	FJ	Total	
Fouling: IMR 8208M	2	3,000	2	1							3	1.0
IMP HPC11	2	3,000		12		1	11	3	1		28	9.3
WC 846	3	4,500	3	2				4	2	25	36	8.0
Functioning: IMR 8208M	2	9,000		10	8		2		10	3	33	3.7
IMR HPC11	2	9,000		103		94	4		7	1	209	23.2
WC 846	2	9,000		3	13		4		2	14	36	4.0
Fouling: mixed lots	1	2,100							1		1	.5
Functioning: 8208M	1	1,100		1			4		1	3	9	8.2
same JPC11		1,100							4		4	3.6
weapon WC 846		1,100					14		1	14	29	26.4
Functioning: mixed lots ammo conditioned at: +160°, +125°, +70°, -65° and -80°	2	2,920		25			1		2	16	44	15.1
Subtotal: 8208M		13,100	2	12	8		6		11	6	45	3.4
HPC11		13,100		115		95	15	3	12	1	241	18.4
WC846		14,600	3	5	13		18	4	5	53	101	6.9
Mixed		5,020		25			1		3	16	45	8.9
Total — all firings		45,820	5	157	21	95	40	7	31	76	432	9.4

Inclosure 6-2

TABLE 33 — USACDC (CDCIA) SUMMARY REPORT, SAWS TROOP ACCEPTABILITY TEST, 3 JUNE 1966

Test Command	Weapon	Rounds Fired	Malfunctions														Number per 1,000 Rounds
			BCS	BP	BOB	BUB	DF	FBC	FBR	FF	FFR	FJ	FTR	FX	Other	Total	
USARAL	XM16E1	32,522				1	3	5	1	3	2	2			4	21	.6
	M14	36,237	2		2			4		5				2	2	17	.5
USCONARC	XM16E1	22,726							267						196	463	20.4
	M14	54,291													112	112	2.1
USAREUR	XM16E1	61,608					6	2	5	4			1		4	22	.4
	M14	49,479		5				1		2						8	.2
USARPAC	XM16E1	83,598		2							3				12	17	.2
	M14	61,595		5											6	11	.2
USARSO	XM16E1	14,566													6	6	.4
	M14	11,012									3				4	7	.6
Total — all commands	XM16E1	215,020		2		1	9	7	273	7	5	2	1		222	529	2.5
	M14	212,614	2	10	2			5		7	3			2	124	155	.7

Inclosure 6-2

TABLE 34 — USAWECOM EVALUATION OF DRI SLIDE AS A LUBRICANT FOR SMALL ARMS WEAPONS, TECHNICAL REPORT 66-2397, AUGUST 1966

Test	Weapon	Rounds Fired	Malfunctions					Number per 1,000 Rounds
			FF	FFR	FJ	FX	Total	
Ambient	M16	400					C	.0
	M14	800	1	2		2	5	6.3
Dust	M16	300	1		1		2	6.7
	M14	600	3				3	5.0
Sand	M16	300					0	.0
	M14	713	22	13	20		55	77.1
-50°F	M16	100	1				1	10.0
	M14	200					0	.0
Total — all tests	M16	1,100	2		1		3	2.7
	M14	2,313	26	15	20	2	63	27.2

Inclosure 6-2

TABLE 35 — U.S. AIR FORCE MARKSMANSHIP SCHOOL TEST OF M16 RIFLE BARRELS WITH CHROME CHAMBERS (PROJECT 38-67), APRIL 1967

Weapon/Barrel	Rounds Fired	Malfunctions							Number per 1,000 Rounds
		BP	DF	FF	FFR	FJ	FX	Total	
M16 with chrome barrel	65,780	15	2	36		63	17	133	2.0
M16 without chrome barrel	46,080	7	11	78	1	22	65	184	4.0
Total — all firings	111,860	22	13	114	1	85	82	317	2.8

Inclosure 6-2

TABLE 36 — U.S. ARMY ARCTIC TEST CENTER ENGINEER DESIGN TEST OF PRESERVATIVE LUBRICANTS FOR SMALL ARMS WEAPONS UNDER ARCTIC WINTER AND SPRING BREAKUP CONDITIONS, 25 MAY 1967

Test	Lubricant	Weapon	Rounds Fired	Malfunctions									Number per 1,000 Rounds
				BP	FBC	FF	FFR	FJ	FX	RC	LP	Total	
Semiautomatic firing	LAW[a/]	M16A1	2,810		1	7	1			1		10	3.6
		M14	2,643	4	2		1					7	2.6
	LSA	M16A1	2,880			4		3	1			8	2.8
		M14	2,880	1	1							2	.7
	A	M16A1	2,589	1		4			1		1	7	2.7
		M14	2,682	2								2	.7
	B	M16A1	2,880			5						5	1.7
		M14	2,880		1							1	.3
	S/F	M16A1	2,400			2	1					3	1.3
		M14	2,400	2	6	1	3	2				14	5.8
Subtotal		M16A1	13,559	1	1	22	2	3	2	1	1	33	2.4
(by weapon)		M14	13,485	9	10	1	4	2				26	1.9
Automatic firing	LAW	M16A1	7,200		1	10	6	5				22	3.1
		M14	7,070	3	2							5	.7
	LSA	M16A1	7,120		1	6	6	3	1			17	2.4
		M14	7,200	2	3		4	1				10	1.4
	A	M16A1	7,182			4	3	2	1			10	1.4
		M14	7,200	1	6		2					9	1.3
	B	M16A1	7,200		2	6	5	2	1			16	2.2
		M14	6,312	4	2							6	1.0
	S/F	M16A1	6,000	1		2	4	1				8	1.3
		M14	6,000	2	19	5	8	2	1			37	6.2
Subtotal		M16A1	34,702	1	4	28	24	13	3			73	2.1
(by weapon)		M14	33,782	12	32	5	14	3	1			67	2.0

Inclosure 6-2

TABLE 36 — continued

Test	Lubricant	Weapon	Rounds Fired	Malfunctions									Number per 1,000 Rounds
				BP	FBC	FF	FFR	FJ	FX	RC	LP	Total	
Several days firing without cleaning	LAW	M16A1	2,300		4	19	1					24	10.4
		M14	2,300	1	16	3	2		1			23	10.0
	LSA	M16A1	2,200		5	11	4	1				21	9.5
		M14	2,400	1	9	2	2					14	5.8
	A	M16A1	2,300		1	5	1					7	3.0
		M14	2,310	1	3	2						6	2.6
	B	M16A1	2,400	1	1	4	2		1			9	3.8
		M14	2,265	1	6	3	1					11	4.9
	S/F	M16A1	2,400		3	2	4					9	3.8
		M14	2,400		8	3	1					12	5.0
Subtotal (by weapon)		M16A1	11,600	1	14	41	12	1	1			70	6.0
		M14	11,675	4	42	13	6		1			66	5.7
3 days firing	LAW	M16A1	4,800		13	104	6	1				124	25.8
		M14	4,800		3	2	2	2				9	1.9
	LSA	M16A1	4,800		8	80	1	2	2			93	19.4
		M14	4,800		1			1				2	.4
	A	M16A1	4,800	1	1	44		6	4			56	11.7
		M14	4,800	1	9	3		1				14	2.9
	B	M16A1	4,800		7	76	2	1				86	17.9
		M14	4,800		3		10	6	2			21	4.4
	S/F	M16A1	4,800		1	32	3	2	2			40	8.3
		M14	4,800		176	2	8	9	24			219	45.6
Subtotal (by weapon)		M16A1	24,000	1	30	336	12	12	8			399	16.6
		M14	24,000	1	192	7	20	19	26			265	11.0

Inclosure 6-2

TABLE 36 — continued

Test	Lubricant	Weapon	Rounds Fired	Malfunctions BP	FBC	FF	FFR	FJ	FX	RC	LP	Total	Number per 1,000 Rounds
Totals by lubricant (all tests)	LAW	M16A1	17,110		19	140	14	6		1		180	10.5
		M14	16,813	8	23	5	5	2	1			44	2.6
	LSA	M16A1	17,000		14	101	11	9	4			139	8.2
		M14	17,280	4	14	2	6	2				28	1.6
	A	M16A1	16,871	2	2	57	4	8	6		1	80	4.7
		M14	16,992	5	18	5	2	1				31	1.8
	B	M16A1	17,280	1	10	91	9	3	2			116	6.7
		M14	16,257	5	12	3	11	6	2			39	2.4
	S/F	M16A1	15,600	1	4	38	12	3	2			60	3.8
		M14	15,600	4	209	11	20	13	25			282	18.1
Totals by weapon (all lubricants — all tests)		M16A1	83,861	4	49	427	50	29	14	1	1	575	6.9
		M14	82,942	26	276	26	44	24	28			424	5.1

[a] Lubricant types: LAW = MIL-L-14,107, a standard Arctic weapons lubricant; LSA = MIL-L-46,000A, a semifluid, synthetic base, preservative lubricating oil (approved for use on the M16A1 above 0°F); A = an experimental lubricant similar to LSA with the thickener omitted; B = an experimental lubricant similar to LSA with the synthetic base fluid changed; S/F = MIL-L-46010A, a resin-bonded, heat-cured, solid film lubricant.

FOR OFFICIAL USE ONLY

TABLE 37 —USATECOM MILITARY POTENTIAL TEST OF WEAPON LUBRICANTS, TECHNICAL REPORT 67-1380, JUNE 1967

Test	Lubricant	Rounds Fired	Malfunctions														Number per 1,000 Rounds
			BCS	BOB		FBA	FBR	FF	FF-1	FFR	FJ	FTR	FX	IP	SR	Total	
Salt water immersion	Code A[a]	1,540		2	2	18		26	20	8	9	30	3	3	1	122	79.2
	VV-L	1,400						16	4	12		21	2	2	1	58	41.4
	NRL	2,100					1	23	27			17	4		1	73	34.8
	MIL-L	2,100							1			2	5			8	3.8
Dust	Code A	1,680				1		20	13		9	3			1	47	28.0
	VV-L	1,680						9	11							20	11.9
	NRL	1,680				7		25	15			1	4			52	31.0
	MIL-L	1,680						6	7							13	7.7
Mud	Code A	20						12			7					19	950.0
	VV-L	39		2				19			22					43	1102.6
	NRL	27						21			14					35	1296.3
	MIL-L	41						16			11					27	658.5
Sand drag	Code A	840						7	1		2	3	1			14	16.7
	VV-L	840										35	1			36	42.9
	NRL	840														0	.0
	MIL-L	840														C	.0
Water spray (rain)	Code A	2,883		1				17	12	1					3	34	11.8
	VV-L	3,000						21	53			15				89	29.7
	VV-L w/MIL-G	3,000	1					3	9						1	14	4.7
	NRL	3,000					1	2								3	1.0
	MIL-L	3,000					1	3	6						7	17	5.7

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 37 -- continued

Test	Lubricant	Rounds Fired	Malfunctions													Number per 1,000 Rounds
			BCS	BOB	FBA	FBR	FF	FF-1	FFR	FJ	FTR	FX	IP	SR	Total	
Reliability	Code A	17,260					67	405	35	43	419	10		7	986	57.1
(Schedule I)b/	VV-L	18,000		5		3	16	284	5	11	602			3	929	51.6
	NRL	14,200		2		2	117	344	61	3					529	37.3
	MIL-L	18,000		5			13	231		5	41	1		4	300	16.7
(Schedule II)c/	Code A	18,000		1			55	216	8	18	262	1		1	562	31.2
	VV-L	18,000		3		1	1	9	1	6	289				310	17.2
	NRL	18,000		16		1	10	88	1	4		8		5	133	7.4
	MIL-L	18,000		2			1	3	1		14	7		2	30	1.7
Sequential test series																
Salt water	Code A	1,400						4		3	2				9	6.4
	VV-L	1,400									73				73	52.1
	NRL	1,400						1				1			2	1.4
	MIL-L	1,400						1		1	72				74	52.9
Water spray (rain)	Code A	1,400			4		11	12		3	192		26		248	177.1
	VV-L	1,400			3		50	25	4		139		33		254	181.4
	NRL	1,400						2							2	1.4
	MIL-L	1,400		1			3	20			19		6		49	35.0
Dust	Code A	1,400			2		2	13		1			20		38	27.1
	VV-L	1,400			2		62	18			2	5	26	1	116	82.9
	NRL	1,400					4	26		1	3	5			39	27.9
	MIL-L	1,400					1	9		2		4	5		21	15.0
Sand drag	Code A	1,400		1				3		3					7	5.0
	VV-L	1,400									33				33	23.6
	NRL	1,400					1	3			1	4			9	6.4
	MIL-L	1,400						2		1		4			7	5.0

Inclosure 6-2

TABLE 37 — continued

Test	Lubricant	Rounds Fired	Malfunctions														Number per 1,000 Rounds
			BCS	BOB	COEC	FBA	FBR	FF	FF-1	FFR	FJ	FTR	FX	IP	SR	Total	
Mud	Code A	1,400		3		1	1	22	14		1	136	2	20		200	142.9
	VV-L	1,400				3	1	13	7		1	2	2	27		56	40.0
	NRL	1,400		1				9	48			30	4			92	65.7
	MIL-L	1,400					2	24	8			19	4	18		75	53.6
Reliability	Code A	15,000				8		171	169		5	1		105		459	30.6
	VV-L	14,300				6		138	107	1	1	14		105		372	26.0
	NRL	15,000				5		57	105	14	1	5	8			195	13.0
	MIL-L	15,000				3		35	39	6	5	12	12	52		164	10.9
Dynamic dust	Code A	911		2				21	16				16			55	60.4
	VV-L	1,260			5			9	16				6		1	37	29.4
	NRL	421					1	18	7		2					28	66.5
	MIL-L	1,260	5		1		2	5	9		1		6			29	23.0
	(Tracer) MIL-L	911		3	12		2				2					19	20.9
Liberal lubrication d/	Code A	8,400									2		1		1	4	.5
	VV-L	8,400					3					1				4	.5
	NRL	8,400							1		1	1	1		2	6	.7
	MIL-L	8,400						2								2	.2
Subtotal Adverse Conditions (by lubricant)	Code A	14,874		9	2	26	1	138	108	9	38	366	22	69	5	793	53.3
	VV-L	15,219	1	2	5	8	1	202	143	16	23	320	16	88	4	829	54.5
	NRL	15,068		1		7	3	103	129		17	52	22		1	335	22.2
	MIL-L	16,832	5	4	13		7	58	63		18	112	23	29	7	339	20.1

Inclosure 6-2

TABLE 37 — continued

Test	Lubricant	Rounds Fired	Malfunctions														Number per 1,000 Rounds
			BCS	BOB	COEC	FBA	FBR	FF	FF-1	FFR	FJ	FTR	FX	IP	SR	Total	
Subtotal Reliability (by lubricant)	Code A	50,260		1		8		293	790	43	66	682	11	105	8	2,007	39.9
	VV-L	50,300		8		6	4	155	400	7	18	905		105	3	1,611	32.0
	NRL	47,200		18		5	3	184	537	76	8	5	16		5	857	18.2
	MIL-L	51,000		7		3		49	273	7	10	67	20	52	6	494	9.7
Total Adverse Conditions		61,993	6	16	20	41	12	501	443	25	96	850	83	186	17	2,296	37.0
Total Reliability		198,760		34		22	7	681	2,000	133	102	1,659	47	262	22	4,969	25.0
Total - all firings		294,353	6	50	20	63	22	1,184	2,444	158	201	2,511	132	448	42	7,281	24.7

[a]Lubricant Code: Code A = Dri-Slide; VV-L = VV-L-800; NRL = Naval Research Laboratory Experimental Lubricant; MIL-1 = MIL-L-46000A; VV-L w/MIL-G = VV-L-800 with MIL-G-46003 (rifle grease).

[b]Schedule I: A cleaning and lubrication schedule which provided for cleaning and/or lubricating the weapon only when excessive malfunctions occurred.

[c]Schedule II: A cleaning schedule which provided for cleaning and lubricating the weapons every 1,000 rounds.

[d]The liberal lubrication test is not included in the subtotals for adverse conditions or reliability; it is included only in Total - all firings.

TABLE 38 — USATECOM (D&PS) FINAL REPORT ON ENGINEER DESIGN TEST OF MAGAZINE, 20-ROUND DISPOSABLE, FOR M16A1 RIFLE, OCTOBER 1967

Test	Magazine[a]/	Rounds Fired	Malfunctions									Number per 1,000 Rounds
			BCS	BOB	DF	FBC	FBR	FF	FF-1	SR	Total	
Adverse Conditions												
Dust	1-A	200				1	1		4		6	30.0
	5-B	200		1	1		3		9		14	70.0
	Standard	200				1			3		4	20.0
Sand	1-A	200						4	8		12	60.0
	5-B	200				1	6	1	10	1	19	95.0
	Standard	200							1		1	5.0
Mud	1-A	196		2		4		7			13	66.3
	5-B	153		4		1	7	14	3	2	31	202.6
	Standard	195		4				8			12	61.5
Water immersion	1-A	200									0	.0
	5-B	200					3		2		5	25.0
	Standard	60					1				1	16.7
High temperature	1-A	2,398				1	19				20	8.3
	5-B	1,158		3		3	51			1	58	50.1
	Standard	2,316		4		38	48			1	91	39.3
Low temperature	1-A	2,399		3			23		4	3	33	13.8
	5-B	1,521	1				59	1			61	40.1
	Standard	2,398				1	16		1	2	20	8.3
Heat and humidity	1-A	200					5				5	25.0
	5-B	200									0	.0
	Standard	200		1							1	5.0

Inclosure 6-2

TABLE 38 — continued

Test	Magazine[a]	Rounds Fired	Malfunctions									Number per 1,000 Rounds
			BCS	BOB	DF	FBC	FBR	FF	FF-1	SR	Total	
Total — Adverse conditions	1-A	5,793		5		6	48	11	16	3	89	15.4
	5-B	3,632	1	8	1	5	129	16	24	4	188	51.8
	Standard	5,569		9		40	65	8	5	3	130	23.3
Function and durability	1-A	2,400					13		3	1	17	7.1
	5-B	2,400					12		19		31	12.9
	Standard	2,399		1			12		3		16	6.7
Total — all tests	1-A	8,193		5		6	61	11	19	4	106	12.9
	5-B	6,032	1	8	1	5	141	16	43	4	219	36.3
	Standard	7,968	10	10		40	77	8	8	3	146	18.3

a Test magazine 1-A was designed by Limited War Laboratory, Aberdeen Proving Ground, Maryland; test magazine 5-B was designed by Rock Island Arsenal; the standard magazine is the 20-round aluminum magazine currently issued.

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TABLE 39 -- USACDCEC REPORT ON RELIABILITY OF THE M16A1 RIFLE DURING PHASE I OF IRUS 70-75
FIELD EXPERIMENTATION, 3 NOVEMBER 1967

Firing Program	Rounds Fired	Malfunctions																Number per 1,000 Rounds
		BOB	BP	BUB	DF	DP	FBC	FBR	FF	FFR	FS	FJ	FX	FZR	IP	Other	Total	
4-9 Man Program	300,335	9	1	7	170	3	14	1	24	42		15	59	3	16	20	384	1.27
5 Man Program	118,192	11		7	41	1		2	30	2		2	64		1	12	173	1.46
Special Program	90,385	2	1	6	38		7		12	2	2	1	68			2	141	1.56
Total	508,912	22	2	20	249	4	21	3	66	46	2	18	191	3	17	34	698	1.37

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 40 -- ABERDEEN PROVING GROUND LETTER REPORT OF INITIAL PRODUCTION TEST OF CHROME PLATED CHAMBERS FOR M16A1 RIFLES, 20 DECEMBER 1967

Test	Rifle Chambers	Rounds Fired	Malfunctions												Number per 1,000 Rounds
			BOB	CDEC	DF	FBC	FBR	FF-1	FFR	FJ	FTR	FX	SR	Total	
Adverse conditions															
Static dust	w/chrome	1,000				3		30					1	34	34.0
	w/o chrome	1,000				1		39					1	41	41.0
Dynamic dust	w/chrome	3,640				3		49					1	53	14.6
	w/o chrome	3,423				4		50				2	6	62	18.1
Saltwater[a] immersion; high temperature/ humidity	w/chrome	360												0	.0
	w/o chrome	360										2		2	5.6
Total adverse conditions	w/chrome	5,000				6		79					2	87	17.4
	w/o chrome	4,783				5		89				4	7	105	22.0
Function and durability	w/chrome	30,000	2	2	1	15	29	1	1	6	2			59	1.96
Total — all tests	w/chrome	35,000	2	2	1	21	29	80	1	6	2		2	146	4.2

[a] Only failures to extract were to be reported.

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 41 — USATECOM (D&PS) FINAL REPORT ON PRODUCT IMPROVEMENT TEST OF REDESIGNED BUFFER FOR M16A1 RIFLE (DPS-2662), JANUARY 1968

Test	Buffer	Ammo	Propel	Rounds Fired	Malfunctions BOB	COEC	DF	FBR	FF	FFR	FF-1	FJ	FX	FTR	Total	Number pe 1,000 Roun
Cyclic rate	Standard	BALL	IMR	240											0	.0
		BALL	BALL	240											0	.0
		TRACER	IMR	240											0	.0
		TRACER	BALL	240											0	.0
	Redesigned	BALL	IMR	240											0	.0
		BALL	IMR	240											0	.0
		TRACER	IMR	240											0	.0
		TRACER	BALL	240											0	.0
High humidity	Standard	BALL	IMR	1,680						1					1	.6
		BALL	BALL	1,680				1		6					7	4.2
		TRACER	IMR	1,680				1	1	1					3	1.8
		TRACER	BALL	1,680				1	2	12					15	8.9
	Redesigned	BALL	IMR	1,680											0	.0
		BALL	BALL	1,680											0	.0
		TRACER	IMR	1,680	12	3		4	1						20	11.9
		TRACER	BALL	1,680	2					1					3	1.8
High temperature	Standard	BALL	IMR	1,700						4					4	2.4
		BALL	BALL	1,700		1		6		5					12	7.1
		TRACER	IMR	1,700				1		8					9	5.3
		TRACER	BALL	1,700				7		14		1			22	12.9
	Redesigned	BALL	IMR	1,700		4									4	2.4
		BALL	BALL	1,700											0	.0
		TRACER	IMR	1,700											0	.0
		TRACER	BALL	1,700	3			2				5	1		11	6.5

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 41 — continued

Test	Buffer	Ammo	Propel	Rounds Fired	Malfunctions BOB	COEC	DF	FBR	FF	FFR	FF-1	FJ	FX	FTR	Total	Number pe 1,000 Roun
Fouling	Standard	BALL	IMR	2,730					5	15	15				35	12.8
		BALL	BALL	2,730				2		7	10				19	7.0
		TRACER	IMR	2,730					1	37	13	1			52	19.0
		TRACER	BALL	2,730						17	20				37	13.6
	Redesigned	BALL	IMR	2,730	2	7			10	1	9				29	10.6
		BALL	BALL	2,730					1		11				12	4.4
		TRACER	IMR	2,730				1	2		10				13	4.8
		TRACER	BALL	2,730			1		9	1	9				20	7.3
Low temperature (-65°F)	Standard	BALL	IMR	3,350	6	15		1	13	28	18				81	24.2
		BALL	BALL	3,350	1	2			16	9	16				44	13.1
		TRACER	IMR	3,350	18	33		3	13	44	10	1			122	36.4
		TRACER	BALL	3,350	12	23			19	45	11				110	32.8
	Redesigned	BALL	IMR	3,350	35	46		2	19	9	27	1			139	41.5
		BALL	BALL	3,350	4	2		1	8	4	16				35	10.4
		TRACER	IMR	3,350	24	44		2	18	1	17	6	3		115	34.3
		TRACER	BALL	3,350	41	54		4	31	8	28	3	2		171	51.0
Extreme attitude functioning	Standard	BALL	IMR	1,570						43					43	27.4
		BALL	BALL	1,570				3	3	173					179	114.0
		TRACER	IMR	1,570						25					25	15.9
		TRACER	BALL	1,570	1				5	34	1				41	26.1
	Redesigned	BALL	IMR	1,570	10	3		2	17		1				33	21.0
		BALL	BALL	1,570				1							1	.6
		TRACER	IMR	1,570	3				15		4				22	14.0
		TRACER	BALL	1,570	1				5	1	2				9	5.7

Inclosure 6-2

TABLE 41 — continued

Test	Buffer	Ammo	Propel	Rounds Fired	Malfunctions: BOR	COEC	DF	FBR	FF	FFR	FF-1	FJ	FX	FTR	Total	Number pe[r] 1,000 Rour[nds]
Accelerated rate	Standard	BALL	IMR	420							1				1	2.4
		BALL	BALL	420	1					2					3	7.1
		TRACER	IMR	420											0	.0
		TRACER	BALL	420											0	.0
	Redesigned	BALL	IMR	420						1					1	2.4
		BALL	BALL	420	2										2	4.8
		TRACER	IMR	420											0	.0
		TRACER	BALL	420											0	.0
Dynamic dust	Standard	BALL	IMR	780					4		12				16	20.5
		BALL	BALL	780					1		5		1		7	9.0
		TRACER	IMR	675	1				4		10				15	22.2
		TRACER	BALL	675	4			1			5	4			14	20.7
	Redesigned	BALL	IMR	780	4				4		10	1			19	24.4
		BALL	BALL	780	3				1		3		2		9	11.5
		TRACER	IMR	675					12		6				18	26.7
		TRACER	BALL	675	1				2		10				13	19.3
Total — all tests except saltwater immersion	Standard	BALL	IMR	12,470	6	15		1	22	91	46				181	14.5
		BALL	BALL	12,470	2	3		12	20	202	31		1		271	21.7
		TRACER	IMR	12,365	19	33		5	19	115	33	2			226	18.3
		TRACER	BALL	12,365	17	23		9	26	123	37	5			240	19.4
	Redesigned	BALL	IMR	12,470	53	60		4	50	10	47	2			226	18.1
		BALL	BALL	12,470	7	2		2	10	4	30		2		57	4.6
		TRACER	IMR	12,365	39	47		7	48	1	37	6	3		188	15.2
		TRACER	BALL	12,365	48	54	1	6	47	11	49	8	3		227	18.4
Saltwater[a/] Immersion	Redesigned	BALL	IMR	900	1	1		1	23	2	5	1	1		35	38.9
		BALL	BALL	900		4		1	39		7			6	57	63.3
		TRACER	IMR	900	1				37	2	1		3	2	46	51
		TRACER	BALL	900		3			15	1	3		1		23	25.6

a/ Only the redesigned buffer was tested.

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TABLE 42 — U.S. MARINE CORPS VIETNAM M16A1 MALFUNCTION REPORTS, JUNE 1967 - FEBRUARY 1968

Time Period	Weapon	Rounds Fired	Malfunctions													Number per 1,000 Rounds
			BP	DF	FCB	FBC	FF	FFR	FJ	FS	FX	IP	RC	Other	Total	
13-30 Jun 67	M16A1[a]/	Unknown	3	14	1		91	32	2	1	625	5		29	803	Unknown
1-13 Jul 67	M16A1[a]/	Unknown		3		2	22	11	2	1	87		4	2	134	Unknown
14 Jul - 10 Aug 67	M16A1[a]/	Unknown				1	42	7	1	6	191	7		16	271	Unknown
Subtotal 13 Jun - 10 Aug 67	M16A1[a]/	Unknown	3	17	1	3	155	50	5	8	903	12	4	47	1,208	Unknown
19-30 Nov 67	M16A1[b]/	2,132,752					321	282	290		1,655		105		2,653	1.244
1-15 Dec 67	M16A1[b]/	1,551,369					1,399	120	506		1,568		36		3,629	2.339
Subtotal 19 Nov - 15 Dec 67	M16A1[b]/	3,684,121					1,720	402	796		3,223		141		6,282	1.705
16-31 Dec 67	M16A1[b]/	1,507,612					380	57	228		826		23		1,514	1.004
	M16A1[c]/	39,750					12	1			9				22	.553
1-15 Jan 68	M16A1[b]/	1,350,765					252	72	95		640		29		1,088	.805
	M16A1[c]/	84,600					23				22				45	.532
16-30 Jan 68	M16A1[b]/	1,498,511					233	53	55		475		18		834	.556
	M16A1[c]/	37,800					2	1			3				6	.159
1-15 Feb 68	M16A1[b]/	1,430,126					315	48	75		370		25		833	.582
	M16A1[c]/	48,100					1	2			2				5	.104
Subtotal 16 Dec 67 - 15 Feb 68	M16A1[b]/	5,787,014					1,180	230	453		2,311		95		4,269	.738
	M16A1[c]/	210,250					38	4			36				78	.371
Total 19 Nov 67 - 15 Feb 68	ALL	9,681,385					2,938	636	1,249		5,570		236		10,629	1.098

[a]M16A1 rifle without new buffer or the chrome plated chamber.
[b]M16A1 rifle with new buffer but without chrome plated chamber.
[c]M16A1 rifle with both the new buffer and the chrome plated chamber.

Inclosure 6-2

TABLE 43 — MALFUNCTION DATA FOR RIFLES FIRING BOTH BALL AND IMR PROPELLANTS (WSEG TEST)

Malfunction	Category I[b] Number	Category I[b] Percentage[a]	Category II[c] Number	Category II[c] Percentage[a]	Category III[d] Number	Category III[d] Percentage[a]	Total Number	Total Percentage	Percentage of Each Type of Malfunction by Category I	II	III
Failure to feed	1,453	49	315	50	23	24	1,791	49	81	18	1
Failure to chamber	356	12	87	14	8	9	451	12	79	19	2
Failure to lock	90	3	25	4	1	1	115	3	77	22	1
Failure to fire	203	7	47	8	16	17	266	7	76	18	6
Failure to extract	119	4	49	8	10	11	178	5	67	27	6
Failure to eject	244	8	31	5	20	22	295	8	83	10	7
Double feed	66	2	3	1	1	1	70	2	94	4	1
Failure of bolt to remain at rear	370	12	22	4	1	1	393	11	94	6	0
All other	57	2	51	8	13	14	121	3	47	42	11
Total	2,958		630		93		3,681				

[a] Percentage of total malfunctions within this category.
[b] I: Immediately corrected by firer without use of tools or cleaning equipment.
[c] II: Corrected by firer, using aid normally available to him.
[d] III: Required armorer assistance.

Inclosure 6-2

TABLE 44 — MALFUNCTION DATA FOR RIFLES FIRING BALL PROPELLANT (WSEG TEST)

Malfunction	Category I[a] Number	Category I[a] Percentage[b]	Category II[c] Number	Category II[c] Percentage[b]	Category III[d] Number	Category III[d] Percentage[b]	Total Number	Total Percentage	Percentage of Each Type of Malfunction by Category I	II	III
Failure to feed	128	15	21	11	1	2	150	14	85	14	1
Failure to chamber	71	9	17	9	3	6	91	9	78	19	3
Failure to lock	62	7	15	8	1	2	78	7	79	19	1
Failure to fire	138	17	36	19	10	21	184	17	75	20	5
Failure to extract	79	10	39	21	7	15	125	12	63	31	6
Failure to eject	231	28	29	15	20	22	280	26	83	10	7
Double feed	41	5	3	2	1	2	45	4	91	7	2
Failure of bolt to remain at rear	47	6	1	1	1	2	49	5	96	2	2
All other	30	4	28	15	4	8	62	6	48	47	5
Total	827		189		48		1,064				

a/ Immediately corrected by firer without use of tools or cleaning equipment.
b/ Percentage of total malfunctions within this category.
c/ Corrected by firer, using aid normally available to him.
d/ Required armorer assistance.

Inclosure 6-2

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TABLE 45 -- MALFUNCTION DATA FOR RIFLES FIRING IMR PROPELLANT (WSEG TEST)

Malfunction	Category I[a/] Number	Category I[a/] Percentage[b/]	Category II[c/] Number	Category II[c/] Percentage[b/]	Category III[d/] Number	Category III[d/] Percentage[b/]	Total Number	Total Percentage	Percentage of Each Type of Malfunction by Category I	II	III
Failure to feed	1,325	62	294	67	22	49	1,641	63	1	18	1
Failure to chamber	285	13	70	16	5	11	360	14	9	19	2
Failure to lock	28	1	10	2	0	0	38	1	4	26	0
Failure to fire	65	3	11	2	6	13	82	3	9	13	7
Failure to extract	40	2	10	2	3	7	53	2	5	19	6
Failure to eject	13	1	2	0	0	0	15	1	87	13	0
Double feed	25	1	0	0	0	0	25	1	100	0	0
Failure to bolt to remain at rear	323	15	21	5	0	0	344	13	94	6	0
All other	27	1	23	5	9	20	59	1	46	39	15
Total	2,131		441		45		2,617				

a/ Immediately corrected by firer without use of tools or cleaning equipment.
b/ Percentage of total malfunctions within this category.
c/ Corrected by firer, using aid normally available to him.
d/ Required armorer assistance.

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 46 — MALFUNCTION DATA ANALYSIS (WSEG TEST)

Malfunction	Category I[a] Number	Category I[a] Percentage[d]	Category II[b] Number	Category II[b] Percentage[d]	Category III[c] Number	Category III[c] Percentage[d]	Total Number	Total Percentage[d]
All malfunctions								
Ball propellant								
Chromed chamber	463	16	86	14	33	35	582	16
Unchromed chamber	364	12	103	16	15	16	482	13
IMR propellant								
Chromed chamber	970	33	209	33	19	20	1,198	33
Unchromed chamber	1,161	39	232	37	26	28	1,419	39
Total	2,958		630		93		3,681	
Failure to feed								
Ball propellant								
Chromed chamber	64	4	9	3	0		73	4
Unchromed chamber	64	4	12	4	1	4	77	4
IMR propellant								
Chromed chamber	583	40	136	43	13	57	732	41
Unchromed chamber	742	51	158	50	9	39	909	51
Total	1,453		315		23		1,791	

a/ Immediately corrected by firer without use of tools or cleaning equipment.
b/ Corrected by firer, using aid normally available to him.
c/ Required armorer assistance.
d/ Percentage of total malfunctions within this category.

Inclosure 6-2

TABLE 46 — continued

Malfunction	Category I[a] Number	Category I[a] Percentage[d]	Category II[b] Number	Category II[b] Percentage[d]	Category III[c] Number	Category III[c] Percentage[d]	Total Number	Total Percentage[d]
Failure to chamber								
Ball propellant								
Chromed chamber	36	10	7	8	2	25	45	10
Unchromed chamber	35	10	10	11	1	13	46	10
IMR propellant								
Chromed chamber	160	45	42	48	2	25	204	45
Unchromed chamber	125	35	28	32	3	37	156	35
Total	356		87		8		451	
Failure of bolt to remain to rear								
Ball propellant								
Chromed chamber	28	8	1	5	0	0	29	7
Unchromed chamber	19	5	0	0	1	100	20	5
IMR propellant								
Chromed chamber	160	43	6	27	0	0	166	42
Unchromed chamber	163	44	15	63	0	0	178	45
Total	370		22		1		393	

TABLE 46 — continued

Malfunction	Category I[a] Number	Category I[a] Percentage[d]	Category II[b] Number	Category II[b] Percentage[d]	Category III[c] Number	Category III[c] Percentage[d]	Total Number	Total Percentage[d]
Failure to eject								
Ball propellant								
Chromed chamber	157	64	19	62	18	90	194	66
Unchromed chamber	74	30	10	32	2	10	86	29
IMR propellant								
Chromed chamber	1	1	1	3	0	0	2	1
Unchromed chamber	12	5	1	3	0	0	13	4
Total	244		31		20		295	
Failure to fire								
Ball propellant								
Chromed chamber	88	43	22	49	9	56	119	45
Unchromed chamber	50	25	14	30	1	6	65	24
IMR propellant								
Chromed chamber	30	15	6	13	2	13	38	14
Unchromed chamber	35	17	5	11	4	25	44	17
Total	203		47		16		266	

Inclosure 6-2

TABLE 46 — continued

Malfunction	Category I[a] Number	Category I[a] Percentage[d]	Category II[b] Number	Category II[b] Percentage[d]	Category III[c] Number	Category III[c] Percentage[d]	Total Number	Total Percentage[d]
Failure to extract								
Ball propellant								
Chromed chamber	31	26	10	20	2	20	43	24
Unchromed chamber	48	40	29	59	5	50	82	46
IMR propellant								
Chromed chamber	9	8	1	2	0	0	10	6
Unchromed chamber	31	26	9	18	3	30	43	24
Total	119		49		10		178	
Failure to lock								
Ball propellant								
Chromed chamber	32	36	4	16	0	0	36	31
Unchromed chamber	30	33	11	44	1	100	42	36
IMR propellant								
Chromed chamber	6	7	2	8	0	0	8	7
Unchromed chamber	22	24	8	32	0	0	30	26
Total	90		25		1		116	

TABLE 46 — continued

Malfunction	Category I[a] Number	Category I[a] Percentage[d]	Category II[b] Number	Category II[b] Percentage[d]	Category III[c] Number	Category III[c] Percentage[d]	Total Number	Total Percentage[d]
Double feed								
Ball propellant								
Chromed chamber	15	23	2	67	0	0	17	24
Unchromed chamber	26	39	1	33	1	100	28	40
IMR propellant								
Chromed chamber	7	11	0	0	0	0	7	10
Unchromed chamber	18	27	0	0	0	0	18	26
Total	66		3		1		70	
All other								
Ball propellant								
Chromed propellant	12	21	12	24	2	15	26	21
Unchromed chamber	18	32	16	31	2	15	36	30
IMR propellant								
Chromed chamber	14	25	15	29	2	15	31	26
Unchromed chamber	13	23	8	16	7	54	28	23
Total	57		51		13		121	

TABLE 47 — MALFUNCTION, BY TYPE, FOR EACH CHAMBER AND PROPELLANT COMBINATION (WSEG TEST)

Weapon and Propellant	Rounds Fired	Malfunction[a]									Number per 1,000 Rounds
		DF	FBC[b]	FBR	FF	FFR	FJ	FX	Other	Total	
M16A1 with chrome chamber firing ball propellant	272,000	17	81	29	73	119	194	43	26	582	2.14
M16A1 with chrome chamber firing IMR propellant	272,000	7	212	166	732	38	2	10	31	1,198	4.40
Subtotal with chrome chamber	544,000	24	293	195	805	157	196	53	57	1,780	3.27
M16A1 without chrome chamber firing ball propellant	272,000	28	88	20	77	65	86	82	36	482	1.77
M16A1 without chrome chamber firing IMR ball propellant	272,000	18	186	178	909	44	13	43	28	1,419	5.22
Subtotal without chrome chamber	544,000	46	274	198	986	109	99	125	64	1,901	3.49
Subtotal ball propellant	544,271	45	169	49	150	184	280	125	62	1,064	1.95
Subtotal IMR propellant	543,864	25	398	344	1,641	82	15	53	59	2,617	4.81
Total - all firings	1,088,135	70	567	393	1,791	266	295	178	121	3,681	3.38

[a]See Inclosure 6-1 for definitions of malfunction abbreviations.

[b]Includes failure to chamber and failure to lock.

TABLE 48 — MALFUNCTIONS OCCURRING IN THE WSEG PANAMA TEST

Malfunction	Propellant/Chamber Finish Combinations								Subtotals								Total All Firings	
	Ball/ Chrome		IMR/ Chrome		Ball Non-Chrome		IMR Non-Chrome		Chrome Chamber		Non-Chrome Chamber		Ball Propellant		IMR Propellant			
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
Double feed	17	.06	7	.03	28	.10	18	.07	24	.04	46	.08	45	.08	25	.05	70	.06
Failure of bolt to close (includes failure to lock and chamber)	81	.30	212	.78	88	.32	186	.68	293	.54	274	.50	169	.31	398	.73	567	.52
Failure of bolt to remain to rear	29	.11	166	.61	20	.07	178	.65	195	.36	198	.36	49	.09	344	.6	393	.36
Failure to feed	73	.27	732	2.69	77	.28	909	3.34	805	1.48	986	1.81	150	.28	1,641	3.02	[illegible]	1.65
Failure to fire	119	.44	38	.14	65	.24	44	.16	157	.29	109	.20	184	.34	82	.15	266	.24
Failure to eject	194	.71	2	.01	86	.32	13	.05	196	.36	99	.18	280	.51	15	.03	295	.27
Failure to extract	43	.16	10	.04	82	.30	43	.16	53	.10	125	.23	125	.23	53	.10	178	.16
Other	26	.10	31	.11	36	.13	28	.10	57	.10	64	.12	62	.11	59	.11	121	.11
Totals	582	2.14	1,198	4.40	482	1.77	1,419	5.22	1,780	3.27	1,901	3.49	1,064	1.95	2,617	4.81	3,681	3.38
Rounds fired	272,000		272,000		272,000		272,000		544,000		544,000		544,271		543,864		1,088,135	

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 49 — SUMMARY OF MALFUNCTIONS, COLT'S 6,000-ROUND ENDURANCE TESTS

Date	Rifle Lot Numbers	Number Rifles	Rounds Fired	Malfunctionsa/										Number per 1,000 Rounds	Propellant
				BP	FBC	FBR	FF	FFR	F2R	FJ	FX	Other	Total		
1964 MARb/	1	1	6,000	1	1								2	.33	IMR 4475
APR	2,3,3A,3B,4	5	24,700	5		11	7		8				31	1.26	IMR 4475
MAY	4A,4B,5,6,1X	5	30,000	4		2	2						8	.27	IMR 4475
JUN	7,2X,3X,8	4	24,000	3		1	3		1	4			12	.50	IMR 4475
JUL	4X,5X,6X,6XA,6XB	5	26,000	3		2	1			6			12	.46	IMR 4475
AUG	7X,8X,9X,9XA,9XB	5	29,431	4	1	1				12			18	.61	IMR 4475 + CR 8136
SEP	10X,11X,12X	3	18,000	1		4				3			8	.44	IMR 4475 + CR 8136
OCT	13X,13XA,13XB, 14X	4	19,004	2						11	1		14	.74	IMR CR 813
NOV	15X,M15X,16X	3	12,364			1	8						9	.73	IMR CR 813
DEC	16XA,16XB, 17X,18X	4	24,000			1	6			3			10	.42	IMR CR 813
Subtotal 1964		39	213,499	23	2	23	27		9	39	1		124	.58	

Inclosure 6-2

TABLE 49 — continued

Date	Rifle Lot Numbers	Number Rifles	Rounds Fired	Malfunctions a/										Number per 1,000 Rounds	Propellant
				BP	FBC	FBR	FF	FFR	F2R	FJ	FX	Other	Total		
1965															
JAN	19X,20X	2	12,000	3		1	2						6	.50	IMR CR 81
FEB	21X,22X	2	12,000	2									2	.17	IMR CR 81
MAR	23X,24X	2	12,000	2			2			2			6	.50	IMR CR 81
APR	25X,26X,27X	3	18,000	2			4		1				7	.39	IMR CR 81
MAY	28X,29X	2	12,000	3								1	4	.33	IMR CR 81
JUN	30X,31X	2	12,000	2						1			3	.25	IMR CR 81
JUL	32X	1	6,000	1			2	1		1			5	.83	IMR CR 81
AUG	33X,34X	2	12,000	3								1	4	.33	IMR CR 81
SEP	35,36	2	12,000	1	1		2	1					5	.42	IMR CR 81
OCT	37,38X,39X	3	18,000	3		1	7			1			12	.67	IMR CR 81
NOV	40X,41X,41A, 41B,41C,41D	6	22,184	3	3	1	10			2	2		21	.95	IMR CR 81
DEC	42X,43X	2	12,000	3			2			1			6	.50	IMR CR 81
Subtotal 1965		29	160,184	28	4	3	31	2	1	8	2	2	81	.51	

Inclosure 6-2

TABLE 49 — continued

Date	Rifle Lot Numbers	Number Rifles	Rounds Fired	Malfunctions[a]										Number per 1,000 Rounds	Propellant
				BP	FBC	FBR	FF	FFR	F2R	FJ	FX	Other	Total		
1966															
JAN	44X,45X	2	12,000	2						1			3	.25	IMR CR 813
FEB	46,47	2	12,000	4			4			2			10	.83	IMR CR 813
MAR	48X,49X	2	12,000	1		1							2	.17	IMR CR 813
APR	50,51	2	12,000	2							2		4	.33	IMR CR 813
MAY[c]	1,2	2	12,000	1			2						3	.25	IMR CR 813
JUN	3,4	2	12,000	1			4			1			6	.50	IMR CR 813
JUL	5	1	6,000				1						1	.17	IMR CR 813
AUG	6,7	2	12,000				5	2				1	8	.67	IMR CR 813
SEP	8,8A,8B,9	4	19,143	1			3	3			2		9	.47	IMR CR 813
OCT	10,11	2	12,000									1	1	.08	IMR CR 813
NOV	12,13	2	12,000	1	2		4	3	1			1	12	1.00	IMR CR 813
DEC	14,15,16	3	18,000	4			9	3		3			19	1.06	IMR & BALL
Subtotal 1966		26	151,143	17	2	1	32	11	1	7	4	3	78	.52	

Inclosure 6-2

TABLE 49 — continued

Date	Rifle Lot Numbers	Number Rifles	Rounds Fired	Malfunctions[a]										Number per 1,000 Rounds	Propellant
				BP	FBC	FBR	FF	FFR	F2R	FJ	FX	Other	Total		
1967															
JAN	17,18,19	3	18,000	1			2		2	3		2	10	.56	WC 846 BAL
FEB	20,21,22	3	18,000										0	.00	WC 846 BAL
MAR	23,24,25	3	18,000				3						3	.17	WC 846-BAL
APR	26,27,27A,27B,28	5	24,523	1	1		11		1	3		1	18	.73	BALL & IMR
MAY	29,30,31	3	18,000	1	1		4			2			8	.44	BALL & IMR
JUN	32,33,34	3	18,000				3			1			4	.22	WC 846 BAL
JUL	None	0	0										-	--	
AUG	35,36,36A,36B	4	20,097	1	1		4	1		7			14	.70	BALL & IMR
SEP	37,38,39	3	18,000							2			2	.11	WC 846 BAL
OCT	40,41,42	3	18,000	1			1	1		5			8	.44	BALL & IMR
NOV	43,43A,43B,44,45	5	25,216	2			12		1	9			24	.95	WC 846 BAL
DEC	46,47,48,49	4	24,000				1			1			2	.08	WC 846 BAL
Subtotal 1967		39	219,836	7	3		41	2	4	33		3	93	.42	
1968															
JAN	50,51,52	3	18,000		1					1			2	.11	WC 845 BAL
FEB	53,54,55	3	18,000										0	.00	WC 846 BAL
Subtotal 1968		6	36,000		1					1			2	.06	
Total - all tests		139	780,662	75	12	27	131	15	15	88	7	8	378	.48	

[a]See Inclosure 6-1 for definitions of malfunction abbreviations.
[b]Contract DA-11-199-AMC-508 (Mar 64 - Apr 66).
[c]Contract DAAF03-66-C-0018 (May 1966 to present).

TABLE 50 — SUMMARY OF COLT'S FINAL INSPECTION REPORTS FOR M16, XM16E1, M16A1 RIFLES, 1964

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Function Firing										
Number fired	356	1,597	3,244	6,124	2,556	7,061	9,534	7,637	8,575	8,702
Number accepted	348	1,547	3,175	5,970	2,421	6,610	8,093	6,449	7,605	8,064
Percent accepted	97.8	96.8	97.9	97.5	94.7	93.6	84.9	84.4	88.7	92.7
Average rounds fired per weapon	60	58	61	63	57	65	70.8	75	75.1	57.3
Ammunition lots used	5027	5027	6000	6000 5031	5031	5037 6000	5037 5044	5044	5044 5045	5045
Target Inspection										
Number fired	348	1,574	3,188	6,209	2,481	7.181	8,746	6,803	7,955	8,384
Number accepted	328	1,512	3,163	5,970	2,436	6,610	8,119	6,425	7,597	8,040
Percent accepted	94.3	97.7	99.2	96.2	98.2	92	92.8	94.4	95.5	95.9
Ammunition quality	Good	Good	Good	Good	Good	Good	Good	Poor	Fair	Good
Ammunition lots used	5027	5027	5027	6000	5031	6000	5037 6000	5037	5037 5053	5045 5053
AccuracyInspection										
Number fired	348	1,512	3,110	5,983	2,436	6,727	8,126	6,493	7,654	8,091
Number accepted	327	1,512	3,107	5,970	2,436	6,610	8,035	6,423	7,597	8,028
Percent accepted	94	100	99.9	99.8	100	98.3	98.9	98.9	99.3	99.2

TABLE 50 — 1964 continued

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Final Inspection										
Number in initial inspection	327	1,512	3,059	5,970	2,436	6,469	8,068	6,423	7,597	8,028
Number accepted	134	1,011	1,947	3,890	1,844	4,594	5,822	4,762	5,824	5,940
Percent accepted	41	66.8	63.6	65.2	75.7	71	72.2	74.1	76.7	74
Number in repeat inspection	192	496	1,069	2,033	549	1,875	2,246	1,661	1,742	2,088
Number accepted	192	496	1,069	2,033	549	1,875	2,246	1,650	1,733	2,060
Percent accepted	100	100	100	100	100	100	100	99.3	99.5	98.9
Total number inspected	519	2,008	4,128	8,003	2,985	8,344	10,414	8,084	9,339	10,116
Total number accepted	326	1,507	3,016	5,923	2,393	6,469	8,068	6,512	7,557	8,000
Total percentage accepted	62.8	75	73	74	80	77.5	77.5	80.6	80.9	79

FOR OFFICIAL USE ONLY

TABLE 50 — SUMMARY OF COLT'S FINAL INSPECTION REPORTS FOR M16, XM16E1, M16A1 RIFLES, 1965

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	De
Function Firing												
Number fired	9,145	8,649	8,561	8,342	8,344	8,239	4,401	8,219	12,654	6,290	8,612	10,69
Number accepted	8,606	8,263	8,176	8,000	8,000	8,034	4,233	8,021	12,051	6,000	8,255	10,13
Percent accepted	94.1	95.5	95.5	95.9	95.9	97.5	96.2	97.6	95.2	95.4	95.9	94.
Average rounds fired per weapon	63	58.8	62	55.8	59.85	58.6	54.8	58	63.5	58.6	59	6
Ammunition lots used	a/	5061 5053	b/	5054 5070	5070	5069 5070	5069 5061	5061	5060 5061	5060 5135	5135 5060	506 513
Target Inspection												
Number fired	8,898	8,397	8,619	8,494	8,424	8,422	4,450	8,515	12,661	6,483	8,977	11,25
Number accepted	8,606	8,263	8,176	8,200	8,000	8,001	4,233	8,021	12,051	6,000	8,255	10,13
Percent accepted	96.7	98.4	94.9	96.5	95	95	95.1	94.2	95.2	92.5	92	9
Ammunition quality	Good	Fair	Good	Good	Good	Good	Good	Good	Good	c/	Good	Goo
Ammunition lots used	a/	5053	b/	5054 5070	5070	5069 5070	5069 5061	5061	5060 5061	5060 5135	5135 5060	506 513
Accuracy Inspection												
Number fired	8,783	8,289	8,226	8,251	8,076	8,085	4,302	8,079	12,150	6,070	8,606	11,08
Number accepted	8,606	8,245	8,176	8,200	8,000	8,001	4,233	8,021	12,051	6,000	8,255	10,13
Percent accepted	98	99.5	99.4	99.4	99.1	99	98.4	99.3	99.2	98.8	95.9	91.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

TABLE 50 — 1965 continued

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Final Inspection												
Number in initial inspection	8,606	8,245	8,176	8,200	8,000	8,001	4,233	8,021	12,051	6,000	8,255	10,134
Number accepted	5,126	4,216	4,571	5,538	6,250	6,650	3,179	6,415	9,707	4,859	6,931	8,895
Percent accepted	59.6	51.1	55.9	67.5	78.1	83.1	75.1	80	80.5	81.0	84	87.8
Number in repeat inspection	3,728	3,977	3,658	2,918	1,783	1,510	748	1,599	2,365	1,143	1,173	1,212
Number accepted	3,450	3,864	3,529	2,662	1,750	1,315	721	1,585	2,344	1,141	1,169	1,205
Percent accepted	92.5	97.2	96.5	91.2	98.1	87.1	96.4	99.1	99.1	99.8	99.7	99.4
Total number inspected	12,334	12,222	11,834	11,118	9,835	9,511	4,981	9,620	14,416	7,143	9,428	11,346
Total number accepted	8,576	8,080	8,100	8,200	8,000	7,965	4,200	8,000	12,044	6,000	8,100	10,100
Total percentage accepted	69.5	66.1	68.4	73.8	81.3	83.7	84.3	83.2	83.5	84.0	85.9	89

[a] 5053, 5061, 5045
[b] 5054, 5053, 5070
[c] 5060 Good; 5135 Poor

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 50 — SUMMARY OF COLT'S FINAL INSPECTION REPORTS FOR M16, XM16E1, M16A1 RIFLES, 1966

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Function Firing												
Number fired	12,095	14,309	14,345	15,589	16,798	18,038	8,479	16,733	17,343	18,793	21,361	25,815
Number accepted	11,449	13,000	13,004	14,633	16,000	17,500	8,000	16,005	16,500	18,000	20,000	25,000
Percent accepted	94.7	90.9	90.7	93.9	95.2	97	94.4	95.6	95.1	95.8	93.6	96.8
Average rounds fired per weapon	63	63	61.4	61	53	63	61	65	64.3	55	62	40.4
Ammunition lots used	5060 5147	5060 5163	5060 5175	a/	a/	5060 5056	5060 5056	5059 5056	b/	5230 5232	5232 5243	c/
Target Inspection												
Number fired	12,519	14,227	14,067	15,813	17,432	18,881	8,541	17,339	18,283	19,735	21,357	26,623
Number accepted	11,449	13,000	13,004	14,633	16,000	17,500	8,000	16,005	16,500	18,000	20,000	25,000
Percent accepted	91.5	91.4	92.4	92.5	91.8	92.7	93.7	92.3	90.2	91.2	93.6	93.9
Ammunition quality	Good	Good	Fair	Good	Good	-	Good	Good	Good	Good	Good	Good
Ammunition lots used	5060 5147	5060 5163	5060 5175	a/	a/	5060 5056	5060 5056	5059 5056	b/	5230 5232	5232 5243	d/
Accuracy Inspection												
Number fired	12,325	13,678	13,201	14,742	16,263	17,986	8,389	16,389	17,003	18,581	20,901	25,915
Number accepted	11,449	13,000	13,004	14,633	16,000	17,500	8,000	16,005	16,500	18,000	20,000	25,000
Percent accepted	92.9	95.0	98.5	99.3	98.4	97.3	95.4	97.7	97.0	96.9	95.7	96.5

Inclosure 6-2

TABLE 50 — 1966 continued

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Final Inspection												
Number in initial inspection	11,289	13,000	13,004	14,633	16,000	17,500	8,000	16,005	16,500	18,000	20,000	25,000
Number accepted	9,780	11,840	11,339	13,132	14,477	15,127	6,357	13,133	14,944	13,721	14,868	20,547
Percent accepted	86.6	91.1	87.2	89.7	90.5	86.4	79.5	82.1	90.6	76.2	74.3	82.2
Number in repeat inspection	1,613	1,211	1,704	1,486	1,547	2,437	1,700	3,164	1,685	4,319	5,203	4,563
Number accepted	1,509	1,160	1,661	1,486	1,523	2,373	1,643	2,872	1,556	4,279	5,132	4,453
Percent accepted	93.6	95.8	97.5	98.8	98.4	97.4	96.6	90.8	92.3	99.1	98.6	97.6
Total number inspected	12,902	14,211	14,708	16,119	17,547	19,937	9,700	19,116	18,185	22,319	25,203	29,563
Total number accepted	11,289	13,000	13,000	14,600	16,000	17,500	8,000	16,005	16,500	18,000	20,000	25,000
Total percentage accepted	87.5	91.5	88.4	90.6	91.2	87.8	82.5	83.7	90.7	80.6	79.4	84.6

a 5060, 5175, 5176
b 5069, 5059, 5222, 5223, 5230, 5118, 5119, WCC6051
c 5243, 5244, 5251
d 5059, 5243, 5244

Inclosure 6-2

TABLE 50 -- SUMMARY OF COLT'S FINAL INSPECTION REPORTS FOR M16, XM16E1, M16A1 RIFLES, 1967

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Function Firing												
Number fired	25,877	25,786	25,718	25,938	25,000	31,342	17,647		30,094	30,003	28,404	35,306
Number accepted	25,000	25,000	25,000	25,000	25,000	30,000	17,000		29,000	29,000	27,600	34,500
Percent accepted	96.6	97.0	97.2	96.4	96.8	95.7	96.3		96.4	96.7	97.2	97.7
Average rounds fired per weapon	46	39.2	40.4	41.8	45	41	36.5		44	42	43.5	41
Ammunition lots used	5251	5244 5255	b/	5258 5259	c/	d/	e/		g/	h/	i/	k/
Target Inspection												
Number fired	27,363	27,527	28,153	29,563	27,798	32,755	19,776		32,197	30,802	29,631	37,118
Number accepted	25,000	25,000	25,000	25,000	25,000	30,000	17,000		29,000	29,000	27,600	34,500
Percent accepted	91.4	90.8	88.8	84.6	89.9	91.6	86		90.1	94.1	93.1	92.9
Ammunition quality	Poor	Good	Good	Fair	Fair	Fair	Good		Fair	Fair	Fair	Good
Ammunition lots used	5251	a/	b/	5258 5259	c/	d/	f/		g/	h/	j/	l/
Accuracy Inspection												
Number fired	25,427	25,330	25,405	28,381	28,402	33,709	19,560		30,163	30,739	28,804	35,632
Number accepted	25,000	25,000	25,000	25,000	25,000	30,000	17,000		29,000	29,000	27,600	34,500
Percent accepted	98.3	98.7	98.4	88.1	88	89	86.9		96.1	94.3	95.8	96.8

FOR OFFICIAL USE ONLY

TABLE 50.— 1967 continued

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	De
Final Inspection												
Number in initial inspection	25,000	25,000	25,000	25,000	25,000	30,000	17,000		29,000	29,000	27,600	34,50
Number accepted	18,188	19,771	20,025	20,271	18,028	23,493	13,534		16,084	18,845	19,437	27,04
Percent accepted	72.8	79.1	80.1	81.1	72.1	78.3	79.6		55.5	65	70.4	78.
Number in repeat inspection	6,981	5,343	5,280	5,142	7,322	7,579	3,785		15,922	1C,789	8,531	7,70
Number accepted	6,812	5,229	4,975	4,729	6,972	6,507	3,466		12,916	10,155	8,163	7,45
Percent accepted	97.6	97.9	94.2	92	95.2	85.9	91.6		81.1	94.1	95.7	96.
Total number inspected	31,981	30,343	30,280	30,142	32,322	37,579	20,785		44,922	39,789	36,131	42,20
Total number accepted	25,000	25,000	25,000	25,000	25,000	30,000	17,000		29,000	29,000	27,600	34,50
Total percentage accepted	78.2	82.4	82.6	82.9	77.3	79.8	81.8		64.6	72.9	76.4	81.

[a] 5059, 5244, 5217, 5255
[b] 5244, 5255, 5258
[c] 5259, 5265, 5266
[d] 5265, 5266, 5286
[e] 5244, 5286, 5287, LCSP 385
[f] 5244, 5286, 5287, LCSP 385, 5242, TW-18179
[g] 5286, 5298, 5307, TW-18179
[h] 5244, 5307, 5308
[i] 5317, 5318, 5325, 5326
[j] 5244, 5325, 5326
[k] 5325, 5326, 5274
[l] 5274, 5244, TW-18179

FOR OFFICIAL USE ONLY

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TABLE 50 — SUMMARY OF COLT'S FINAL INSPECTION REPORTS FOR M16, XM16E1, M16A1 RIFLES, 1963

	Jan
Function Firing	
Number fired	28,185
Number accepted	27,500
Percent accepted	97.6
Average rounds fired per weapon	38.8
Ammunition lots used	a/
Target Inspection	
Number fired	28,933
Number accepted	27,500
Percent accepted	95.0
Ammunition Quality	Fair
Ammunition lots used	a/
Accuracy Inspection	
Number fired	29,094
Number accepted	27,500
Percent accepted	94.5

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 50 — 1968 continued

	Jan
Final Inspeccion	
Number in initial inspection	27,500
Number accepted	21,259
Percent accepted	77.3
Number in repeat inspection	6,976
Number accepted	6,241
Percent accepted	89.5
Total number inspected	34,476
Total number accepted	27,500
Total percentage accepted	79.8

[a] 5274, 5278, 5305

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 51 — WEAPONS REJECTED IN COLT'S FUNCTION FIRING TEST BY TYPE OF MALFUNCTION

Date	Rifle	Total Rifles Tested	Rounds Fired	Malfunctions												Total Rifles Rejected	Malfunctions: Number per 1,000 Rounds
				BCS	DFP	FBC	FBR	FF	FFR	FJ	FS	FTR	FX	F2R	Other		
1964																	
MAR	M16	356	21,360		3						2	2			1	8	.37
APR	M16	1,574	91,292				1	1	4		2	15	2	1	27	53	.58
MAY	M16	3,025	184,525			1	3	8	22	3	7		13		3	60	.33
	XM16E1	219	13,359					2	2		1		1			6	.45
JUN	M16	4,860	306,180				5	15	31	3			20		37	111	.36
	XM16E1	1,264	79,632			1	1	5	13	1	2		3		3	29	.36
JUL	M16	391	22,287						4	14			6		5	29	1.30
	XM16E1	2,165	123,405				4	2	44	34	3		13			100	.81
AUG	M16	565	36,725					3	9	8			4		17	41	1.12
	XM16E1	6,496	422,240					21	45	200		9	21		97	393	.93
SEP	M16	1,079	76,393					7	8	31			4		16	66	.86
	XM16E1	8,455	598,614					175	41	711			34		233	1,194	1.99
OCT	M16	1,350	101,250				3	29	17	220	1	2	6		8	286	2.82
	XM16E1	6,287	471,525			1	19	182	34	827	10	18	67		61	1,219	2.59
NOV	M16	1,422	106,792					32	17	42	9	12	16		20	148	1.39
	XM16E1	7,153	537,190				7	371	73	161	8	31	73		73	797	1.48
DEC	M16	1,363	78,100				4	30	17	16	4		7		50	128	1.64
	XM16E1	7,339	420,525				10	210	100	51	3	9	52		53	488	1.16
Sub-total	M16	15,985	1,024,904		3	1	16	125	129	337	25	31	78	1	184	930	.91
	M16E1	39,378	2,666,490			2	41	968	352	1,985	27	67	264		520	4,226	1.58
Total	(both)	55,363	3,691,394		3	3	57	1,093	481	2,322	52	98	342	1	704	5,156	1.40

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 51 — continued

Date	Rifle	Total Rifles Tested	Rounds Fired	Malfunctions: BCS	DFP	FBC	FBR	FF	FFR	FJ	FS	FTR	FX	F2R	Other	Total Rifles Rejected	Malfunctions: Number per 1,000 Rounds
1965																	
JAN	M16	1,866	117,558				3	22	26	20			22		10	103	.88
	XM16E1	7,279	458,577				20	117	149	32	12	20	69		58	477	1.04
FEB	M16	3,218	189,218				6	26	52	6			21		39	150	.79
	XM16E1	5,431	319,343				4	40	55	22	8	10	50		50	239	.75
MAR	M16	5,376	333,312			13	14	49	36	85	11		32		13	253	.76
	XM16E1	3,185	197,470			4	8	42	15	19			35		12	135	.68
APR	M16	3,310	184,698				3	11	8	4		1	15		20	62	.34
	XM16E1	5,032	280,786				2	20	10	6			20		27	85	.30
MAY	M16	6,251	374,122				16	63	57	47			26		150	359	.96
	XM16E1	2,093	122,650				19	32	18				24		51	144	1.17
JUN	M16	6,230	365,078				1	76	11	10			35		48	181	.50
	XM16E1	2,009	117,727					3	6	3			8		11	31	.26
JUL	M16	3,757	205,884			6	4	45	13	10			22		34	134	.65
	XM16E1	544	35,291					18	3				4		9	34	.96
AUG	M16	6,168	357,744				7	53	23				48		28	159	.44
	XM16E1	2,051	118,958				3	13	5				7		11	39	.33
SEP	M16	8,442	536,067			4	6	221	86	52			53		44	466	.87
	XM16E1	4,212	267,462				3	78	11	2			19		24	137	.51
OCT	XM16E1	6,290	368,594				61	42	30	56			17		84	290	.79
NOV	M16	2,173	138,207			1	7	7	10	12			10		11	58	.45
	XM15E1	6,439	379,901				24	14	24	46	5		20		19	152	.40
DEC	M16	6,408	410,112	110		2	9	16	24	47			23		112	343	.84
	XM16E1	4,289	274,496	1		5	7	12	17	16	1		15		77	151	.55
Sub-total	M16	53,199	3,202,000	110		26	76	589	346	293	11	1	307		509	2,268	.71
	XM16E1	48,954	2,941,555	1		9	151	431	343	202	26	30	288		433	1,914	.65
Total	(both)	102,153	6,143,555	111		35	227	1,020	689	495	37	31	595		942	4,182	.68

-2-

Inclosure 6-2

FOR OFFICIAL USE ONLY

TABLE 51 — continued

Date	Rifle	Total Rifles Tested	Rounds Fired	Malfunctions: BCS	DFP	FBC	FBR	FF	FFR	FJ	FS	FTR	FX	F2R	Other	Total Rifles Rejected	Malfunctions: Number per 1,000 Rounds
1966																	
JAN	M16	8,613	429,219	144		20	36	6	28	41			39		71	385	.90
	XM16E1	3,482	219,366	31		8	1	5	4	39			18		14	120	.55
FEB	M16	14,309	901,467	283		33	60	20	51	510			85		122	1,164	1.29
MAR	M16	14,345	880,783	160		37	56	17	38	682		29	62		74	1,155	1.31
APR	M16	15,589	950,929	170		14	91	21	95	320		20	109		113	953	1.00
MAY	M16	1,039	55,067	9			7		1	8		1	1		8	35	.64
	XM16E1	15,759	835,227	115		16	40	67	60	193		9	128		118	746	.89
JUN	XM16E1	18,038	1,136,394				14	130	69	20			103		170	506	.45
JUL	XM16E1	8,479	517,219				2	100	57	15			54		84	312	.60
AUG	M16	1,694	110,110					14	18	6	1		19		7	65	.59
	XM16E1	15,039	977,535					192	69	39	8		143		123	574	.59
SEP	XM16E1	17,343	1,115,155	33		8	9	73	71	239	32		113		131	709	.64
OCT	XM16E1	18,793	1,033,615	22			12	112	54	142	61		97		181	681	.66
NOV	XM16E1	21,361	1,324,382			60	8	108	101	321	42		169		150	959	.72
DEC	XM16E1	25,815	1,042,926			34	12	116	71	99	9		248		121	710	.68
Sub-total	M16	55,589	3,327,575	766		104	250	78	231	1,567	1	50	315		395	3,757	1.13
	XM16E1	144,109	8,201,819	201		126	98	903	556	1,107	152	9	1,073		1,092	5,317	.65
Total	(both)	199,698	11,529,394	967		230	346	981	787	2,674	153	59	1,388		1,487	9,064	.79

Inclosure 6-2

3

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

TABLE 51 — continued

Date	Rifle	Total Rifles Tested	Rounds Fired	Malfunctions												Total Rifles Rejected	Malfunctions: Number per 1,000 Rounds
				BCS	DFP	FBC	FBR	FF	FFR	FJ	FS	FTR	FX	F2R	Other		
1967																	
JAN	XM16E1	25,877	1,190,342			45	25	270	118	32	3		279		54	826	.69
FEB	XM16E1	25,786	1,010,811			47	10	190	103	12			267		137	766	.76
MAR	M16A1	25,718	1,039,007			9		271	36	18	7		183		135	659	.63
APR	M16A1	25,938	1,084,208			53	15	286	56	41	3		283		106	843	.78
MAY	M16A1	25,832	1,162,440			67	2	122	33	14			318		213	769	.66
JUN	M16	2,203	90,323			9		13	10	3			61		47	143	1.58
	M16A1	29,139	1,194,699			52		143	41	16			309		271	832	.70
JUL & AUG	M16A1	17,647	644,116			26	10	140	28	5			102		174	485	.75
SEP	M16A1 & M16	30,094	1,324,136			81	12	146	51	39	1		154		422	906	.68
OCT	M16A1	30,003	1,260,126			56	140	86	52	24	1		98		417	874	.69
NOV	M16A1 & M16	28,404	1,235,574			42	27	163	59	39			91		195	616	.50
DEC	M16A1	35,306	1,447,546			61	23	279	60				45		319	787	.54
Sub-total	M16a/	2,203	90,323			9		13	10	3			61		47	143	1.58
total	M16A1a/	241,246	10,033,295			416	225	1,787	527	162	14		1,884		1,826	6,841	.68
Total	(both)b/	301,947	12,683,328			548	264	2,109	647	243	15		2,190		2,490	8,536	.67

Inclosure 6-2

4

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

TABLE 51 — continued

Date	Rifle	Total Rifles Tested	Rounds Fired	Malfunctions: BCS	DFP	FBC	FBR	FF	FFR	FJ	FS	FTR	FX	F2R	Other	Total Rifles Rejected	Malfunctions: Number per 1,000 Rounds
1968																	
JAN	M16	9,303	360,956			20	12	27	35	15					150	259	.72
	M16A1	18,882	732,622			23	12	40	30	33					176	314	.43
FEB	M16A1	30,702	1,335,537			29		102	53	34					275	493	.37
Sub-total	M16	9,303	360,956			20	12	27	35	15					150	259	.72
	M16A1	49,584	2,068,159			52	12	142	83	67					451	807	.39
Total	(both)	58,887	2,429,115			72	24	169	118	82					601	1,066	.44
Total	(1964-1968)																
	M16[a]	136,279	8,005,758	876	3	160	354	832	751	2,215	37	82	761	1	1,285	7,357	.92
	M16A1[a]	523,271	25,911,318	202		605	527	4,231	1,861	3,523	219	106	3,509		4,322	19,105	.74
	Both[c]	718,048	36,476,786	1,078	3	888	918	5,372	2,722	5,816	257	188	4,515	1	6,224	27,974	.77

[a] Does not include September and November 1967 because no breakout of M16A1/M16's was available.
[b] Includes all 1967 firings.
[c] Includes all firings.

Inclosure 6-2

5

FOR OFFICIAL USE ONLY

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TABLE 52 — COLT'S RELIABILITY TEST SUMMARY, GOVERNMENT CONTRACT DA-11-199-AMC-508

Date	Lot No.	Lot Size	Rifle Serial Number	Accuracy[a/] Initial	Accuracy[a/] Final	Muzzle Velocity Initial	Muzzle Velocity Final	Cyclic Rate Init'al	Cyclic Rate Final	Average[b/]	Number of Mal-functions	Number of Unserviceable Parts
3/26/64	1	300	040200	1.4	2.2	3109	2996	830	810	819		
4/24/64	2	500	041317	1.5	2.1	3063	3067	880	775	813	8	
4/28/64	3	500	041264	1.8	1.8	3072	3080	805	860	863	6	3
4/28/64	3A	500	041216	1.7	1.8	3106	2997	840	830	831	0	0
4/28/64	3B	500	041114	2.3	1.7	3109	308	850	835	823	1	
4/29/64	4	500	041199	1.5	1.9	3101	3086	885	850	847	11	2
5/05/64	4A	500	041801	1.6	2.4	3078	3065	805	870	821		1
5/05/64	4B	500	041619	1.5	2.2	3091	3063	775	870	830	2	2
5/12/64	5	500	041963	1.5	1.8	3101	2954	816	840	836	2	
5/20/64	6	2300	044652	1.5	1.9	3049	3082	785	855	818		
6/12/64	7	2500	046989	2.4	4.2	3106	3049	810	815	838	3	1
6/26/64	8	2223	049076	4.8	4.4	3130	3155	830	830	848	1	1
5/22/64	1X	200	100025	1.8	2.0	3169	3019	860	830	825		1
6/23/64	2X	600	100227	2.9	2.7	3205	3091	830	855	857	3	
6/25/64	3X	600	100763	3.8	3.8	3106	3101	865	855	868	2	1
7/08/64	4X	500	101718	2.0	4.5	3120	3110	320	855	848	0	1

 FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

TABLE 52 — continued

Date	Lot No.	Lot Size	Rifle Serial Number	Accuracy[a/] Initial	Accuracy[a/] Final	Muzzle Velocity Initial	Muzzle Velocity Final	Cyclic Rate Initial	Cyclic Rate Final	Average[b/]	Number of Mal-functions	Number of Unserviceable Parts
7/08/64	4X	500	101718	2.0	4.5	3120	3110	820	855	848	0	1
7/13/64	5X	500	102633	2.3	3.4	3120	3120	775	840	808	1	1
7/17/64[c/]	6X	1000	103489	3.0		3207		825			6	0
7/20/64	6XA	1000	104351	4.0	4.8	3115	3091	760	890	840	0	0
7/20/64	6XB	1000	104416	4.0	4.8	3150	3107	670	845	830	2	1
8/12/64	7X	2500	106689	3.8	4.0	3175	3082	785	785	816	0	0
8/21/64	8X	2000	107998	3.5	3.1	3140	3140	760	830	838	5	0
8/29/64	9X	2500	109736	3.3		3181		850	835	860	8	2
8/31/64	9XA	2500	109665	4.3	4.6	3111	3100	825	865	849	1	0
8/31/64	9XB	2500	105142	4.0	4.3	3119	3113	855	835	790	0	1
9/17/64	10X	2500	110813	3.0	4.7	3110	3415	820	760	832		1
9/25/64	11X	4000	112303	1.8	4.1	3165	3110	810	865	838	1	
9/29/64	12X	1500	118421	2.2	3.9	3160	3150	740	940	824	2	0
10/26/64[d/]	13X	5000	119016	3.0		3130		748			5	
10/26/64	13XA	5000	212333	3.5	3.7	3156	3102	741	756	795	1	0
10/26/64	13XB	5000	122870	2.5	3.0	3152	3175	673	830	740	1	2

FOR OFFICIAL USE ONLY

TABLE 52 — continued

FOR OFFICIAL USE ONLY

Date	Lot No.	Lot Size	Rifle Serial Number	Accuracy[a] Initial	Accuracy[a] Final	Muzzle Velocity Initial	Muzzle Velocity Final	Cyclic Rate Initial	Cyclic Rate Final	Average[b]	Number of Malfunctions	Number of Unserviceable Parts
10/31/64	14X	1400	119754	2.8	3.0	3082	3175	676	820	775	2	
11/20/64	15X	4708	125926	4.5	3.5	3086	3135	738	842	827	1	
11/24/64	M15X	4708	127736	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	
11/30/64[e]	16X	2849	123984	3.0		3115		760	750	729	8	
12/01/64	16XA	2849	126731	2.5	7.2	3115	3140	633	792	767	3	
12/01/64	16XB	2849	126244	3.0	4.5	3107	3110	742	884	870	2	
12/17/64	17X	3550	054249	3.0	3.3	3180	3106	752	816	818	1	0
12/30/64	18X	4450	135263	3.2	2.3	3145	3101	711	772	759	4	0
1/20/65	19X	4700	139739	2.5	3.5	3150	3101	678	875	794	1	1
1/29/65	20X	3876	131410	3.3	4.2	3140	3135	762	850	830	2	2
2/17/65	21X	4350	057780	4.0	4.5	3141	3130	734	836	839	0	0
2/26/65	22X	3730	145720	4.0	3.2	3185	3130	778	812	840	0	2
3/18/65	23X	4400	060839	2.5	4.2	3101	3120	728	698	750	0	1
3/31/65	24X	3700	064054	2.1	2.1	3106	3018	825	840	813	4	1
4/02/65	25X	1000	153050	2.0	3.2	3106	3082	840	764	797	2	1
4/21/65	26X	3300	156809	3.5	3.5	3145	3094	766	780	788	1	0

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

TABLE 52 — continued

Date	Lot No.	Lot Size	Rifle Serial Number	Accuracy[a/] Initial	Accuracy[a/] Final	Muzzle Velocity Initial	Muzzle Velocity Final	Cyclic Rate Initial	Cyclic Rate Final	Average[b/]	Number of Malfunctions	Number of Unserviceable Parts
4/29/65	27X	3900	068577	3.5	4.0	3115	3127	747	813	800	2	1
5/21/65	28X	3700	75297	2.2	4.8	3157	3155	794	752	771	0	1
5/28/65	29X	4300	147512	3.2	5.0	3137	3150	789	869	847	0	1
6/21/65	30X	4000	159228	4.0	3.2	3149	3134	845	840	822	0	1
6/29/65	31X	3900	079887	3.5	3.8	3140	3112	833	835	815	0	1
7/09/65	32X	4200	082408	3.2	4.5	3104	3098	798	881	827	4	1
8/16/65	33X	4100	087503	3.0	3.0	3177	3101	810	858	829	1	2
8/26/65	34X	3900	87906	2.0	4.0	3115	3089	824	818	824		
9/20/65	35	5900	094436	3.8	4.1	3125	3145	894	746	825	1	0
9/29/65	36	5000	165548	2.6	4.0	3107	3070	866	846	846	3	1
10/02/65	37	2000	096864	3.1	3.6	3140	3115	862	818	821	1	1
10/19/65	38X	3000	167583	3.5	4.0	3101	3125	849	817	855	6	
10/27/65	39X	3000	166481	3.5	3.0	3111	3070	774	846	790	2	1
11/12/65	40X	4800	176346	3.0	3.5	3108	3077	797	800	807	1	1
11/23/65[c/]	41X	3300	179087	2.0		3130					2	
11/24/65[c/]	41A	3300	178818	4.8		3130		904			8	
11/24/65[d/]	41B	3300	180458	3.5		3130		814	790			

FOR OFFICIAL USE ONLY

TABLE 52 — continued

Date	Lot No.	Lot Size	Rifle Serial Number	Accuracy[a] Initial	Accuracy[a] Final	Muzzle Velocity Initial	Muzzle Velocity Final	Cyclic Rate Initial	Cyclic Rate Final	Average[b]	Number of Mal-functions	Number of Unserviceable Parts
11/29/65	41C	3300	175885	3.0	3.2	3135	3110	840	783	817	1	
11/29/65	41D	3300	174703	3.3	3.1	3150	3110	800	753	781	1	2
12/16/65	42X	4500	179473	4.1	4.0	3180	3129	796	758	779	1	1
12/28/65	43X	5600	214667	4.6	3.0	3160	3130	814	786	819	2	2
1/26/66	44X	5600	186978	3.6	2.7	3115	3110	771	691	745	1	0
1/27/66	45X	5600	220889	4.0	4.8	3145	3195	778	714	744		2
2/17/66	46	6500	231823	2.9	4.0	3165	3165	788	737	736	2	
2/25/66	47	6500	233639	2.5	3.0	3110	3120	819	752	764	4	2
3/16/66	48X	6500	240801	3.8	3.4	3159	3210	804	736	740	1	1
3/29/66	49X	6500	249707	2.1	4.0	3150	3155	790	790	736	0	0
4/18/66	50	7200	256412	2.6	3.0	3136	3140	788	723	743		1
4/28/66	51	7400	261106	2.5	3.5	3140	3107	596	769	743	0	1

a Extreme spread in inches at 100 yards.

b Average of measurements taken each 1,000 rounds.

c Test stopped at 2,000 rounds.

d Test suspended at 2,000 rounds because of failure of Lot 41A.

e Rejected.

FOR OFFICIAL USE ONLY

TABLE 53 -- COLT'S RELIABILITY TEST SUMMARY, GOVERNMENT CONTRACT DAAF03-66-C-0018

Date	Lot No.	Lot Size	Rifle Serial Number	Accuracy[a] Initial	Accuracy[a] Final	Muzzle Velocity Initial	Muzzle Velocity Final	Cyclic Rate Initial	Cyclic Rate Final	Average[b]	Number of Mal-functions	Number of Unserviceable Parts
5/16/66	1	8000	194510	3.0	8.7 6.4	3172	3123	783	798	810	2	0
5/26/66	2	8000	198234	3.7	11.0	3159	3132	806	751	764	0	1
6/16/66	3	9000	511734	4.0	4.0	3159	3096	815	738	731	4	0
6/29/66	4	7100	519746	3.4	3.2	3118	3108	777	727	746	1	1
7/28/66	5	8000	527204	3.8	4.5	3144	3215	784	702	718	1	0
8/17/66	6	8000	630169	4.5	3.8	3117	3091	787	707	758	5	0
8/25/66	7	15000	537443	2.6	4.8	3144	3165	601	735	697	3	0
9/13/66[c]	8	8000	540465	3.5		3122		824			3	
9/14/66	8A	8000	545093	3.6	4.3	3170	3155	685	779	775	3	1
9/14/66	8B	8000	538977	3.5	4.8	3145	3135	768	792	768	0	0
9/27/66	9	8500	549248	3.8	4.4	3160	3108	760	785	774	0	0
10/17/66	10	9100	705337	4.0	4.2	3215	3150	812	794	812	1	0
10/27/66	11	8900	558038	2.4	4.5	3160	3121	812	786	780	0	0
11/10/66	12	10000	567906	3.8	3.5	3144	3125	802	688	882	7	1
11/25/66	13	10000	579934	4.0	3.4	3125	3186	776	810	757	4	0
12/08/66	14	10000	588495	4.4	7.0	3186	3217	727	753	723	9	1

FOR OFFICIAL USE ONLY

TABLE 53′ — continued

Date	Lot No.	Lot Size	Rifle Serial Number	Accuracy[a/] Initial	Accuracy[a/] Final	Muzzle Velocity Initial	Muzzle Velocity Final	Cyclic Rate Initial	Cyclic Rate Final	Average[b/]	Number of Malfunctions	Number of Unserviceable Parts
12/19/66	15	10000	595951	4.0	2.8	3110	3144	853	700	784	4	2
12/28/66	16	5000	602194	3.9	4.0	3165	3149	758	772	794	0	1
1/10/67	17	10000	593242	4.8	3.3	3076	3180	832	804	795	2	1
1/20/67	18	10000	631828	3.0	3.0	3197	3151	750	841	766	1	0
1/25/67	19	5000	613745	3.7	3.2	3179	3165	728	846	762	2	0
2/[illegible]/67	20	10000	642098	3.3	3.0	3156	3122	747	741	754	0	0
2/16/67	21	10000	648361	3.3	2.0	3186	3205	742	723	739	0	0
2/24/67	22	5000	663732	4.6	4.0	3192	3221	774	688	719	0	0
3/06/67	23	10000	668143	4.6	4.5	3152	3218	835	746	820	2	0
3/18/67	24	10000	679080	4.0	2.0	3152	3154	736	779	733	0	0
3/27/67	25	5000	681245	4.5	4.8	3160	3190	732	778	764	1	0
4/10/67	26	10000	683901	4.0	4.4	3200	3192	788	693	773	2	0
4/18/67[d/]	27	10000	704217X	3.8		3175		730			5	0
4/19/67	27A	10000	716356	3.6	2.5	3200	3207	734	832	770	4	0
4/19/67	27B	10000	715920	3.0	4.0	3180	3205	776	784	796	3	0
4/25/67	28	5000	716905	4.8	4.5	3145	3171	750	842	797	1	1

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

TABLE 53' — continued

Date	Lot No.	Lot Size	Rifle Serial Number	Accuracy[a] Initial	Accuracy[a] Final	Muzzle Velocity Initial	Muzzle Velocity Final	Cyclic Rate Initial	Cyclic Rate Final	Average[b]	Number of Mal-functions	Number of Unserviceable Parts
5/08/67	29	10000	734976	3.0	4.8	3160	3290	815	708	786	3	1
5/19/67	30	10000	745757	4.0	3.0	3190	3180	835	792	823	2	0
5/26/67	31	5000	738309	4.8	5.2	3162	3220	827	810	822	2	0
6/12/67	32	10000	733046	4.8	7.0	3208	3220	776	835	805	1	0
6/20/67	33	10000	772303	4.0	4.5	3180	3189	745	855	806	3	0
6/27/67	34	10000	785371	2.5	4.5	3190	3207	825	760	771	0	0
8/17/67	35	10000	799626	2.6	3.8	3195	3223	944	826	855	5	1
8/23/67[e]	36	5000	800398	3.2		3056		855			6	0
8/23/67	36A	5000	803781	2.1	3.4	3231	3221	820	774	768	1	0
8/23/67	36B	5000	801164	3.4	5.2	3257	3247	814	760	773	1	0
9/11/67	37	10000	826178	4.2	3.3	3156	3208	806	808	787	0	0
9/20/67	38	10000	814662	4.6	4.2	3185	3210	786	789	785	0	0
9/26/67	39	9000	817689	4.2	4.2	3145	3203	808	744	767	2	0
10/11/67	40	10000	837988	1.5	4.0	3183	3203	815	877	777	1	1
10/18/67	41	10000	849736	4.8	3.8	3175	3074	740	802	762	0	0
10/25/67	42	9000	859759	3.8	4.6	3197	3160	823	801	808	5	0

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

TABLE 53′ — continued

Date	Lot No.	Lot Size	Rifle Serial Number	Accuracy[a/] Initial	Accuracy[a/] Final	Muzzle Velocity Initial	Muzzle Velocity Final	Cyclic Rate Initial	Cyclic Rate Final	Average[b/]	Number of Mal-functions	Number of Unserviceable Parts
11/06/67[f/]	43	10000	872132	4.4		3221		756	746		6	
11/07/67	43A	10000	877930	4.4	3.9	3195	3200	722	744	747	7	0
11/07/67	43B	10000	873820	3.0	4.2	3205	3215	813	888	788	6	
11/14/67	44	10000	869677	4.4	3.4	3165	3110	834	726	743	3	1
11/20/67	45	7600	275238	2.7	2.2	3135	3170	789	746	769	0	0
12/04/67	46	10000	890850	3.6	3.5	3139	3170	900	760	815	1	0
12/11/67	47	10000	916274	3.2	3.2	3124	3169	797	797	794	1	0
12/19/67	48	10000	926529	4.0	4.2	3158	3150	757	792	757	0	0
12/27/67	49	4500	932060	2.4	3.8	3133	3189	743	830	775	0	0
1/09/68	50	10000	939323	4.8	4.6	3129	3101	780	790	726	1	0
1/19/68	51	10000	943225	4.8	4.0	3140	3179	794	752	761	1	0
1/25/68	52	7500	288044	2.9	3.5	3172	3155	762	810	754	0	0

a Extreme spred in inches at 100 yards.
b Average of measurements taken each 1,000 rounds.
c Failed to extract. Test stopped at 1,143 rounds.
d Test suspended at 523 rounds.
e Test stopped at 2,097 rounds.
f Test stopped at 1,216 rounds.

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TABLE 54 -- MALFUNCTIONS AND UNSERVICEABLE PARTS, COLT'S 6000-ROUND ENDURANCE TESTS (26 March 1964 - 28 April 1966)
CONTRACT NUMBER DA-11-199-AMC-508

Malfunction	Number Allowed	Rifle Lot Number 1	2	3P/	3A	3B	4P/	4A	4B	5	6	7	8	1X	2X	3X
Bolt fails to lock	3	1													2b/	
Bolt fails to hold	3						11		1	1		1				
Fails to eject	4											1	1		1c/	2
Fails to feed - CV	4		4						1						1	
Fails to feed - CNV	3		3							1					2	
Fails to fire semiauto	3		1	6		1						1				
Light blow	3															
Fails to assist																
Other	1															
Total malfunctions	11	1	8	6	0	1	11	0	2	2	0	3	1	0	3	2
Unserviceable parts a/																
Hammer spring	0															
Ejector spring	0	1		1			1	1				1	1		1c/	1
Extractor	0								1							
Extractor spring	0								1					1		
Firing pin	0															
Disconnect	0			1												
Other	0			1			1									
Total unserviceable parts	0	1	0	3	0	0	2	1	2	0	0	1	1	1	1	1
Cyclic rate average		819	813	863	831	823	847	821	830	836	818	838	848	825	857	868
Propellant type		(IMR 4475 FOR ALL TESTS ON THIS PAGE)														
Ammunition lot number		5027	5027	5027	5027	5027	5027 WCC 6000	WCC 6000	WCC 6000	WCC 6000	WCC 6000	5031	5031	WCC 6000	5031	5031
Rounds fired		6000	6000	6000	6000	6000	700	6000	6000	6000	6000	6000	6000	6000	6000	6000

Inclosure 6-2

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TABLE 54 — continued

Malfunction	Rifle Lot Number 4X	5X	6Xb/	6XA	6XB	7X	8X	9Xb/	9XA	9XB	10X	11X	12X	13Xb/
Bolt fails to lock							1							
Bolt fails to hold					2			1		1c/	2	1	1	
Fails to eject	2c/	2c/	5		1c/	1c/	4	7	1	1c/	2		1	5
Fails to feed - CV			1							2c/				
Fails to feed - CNV													1a/	
Fails to fire semiauto														
Light blow														
Fails to assist														
Other														
Total malfunctions	0	1	6	0	2	0	5	8	1	0	4	1	2	5
Unserviceable partsa/														
Hammer spring														
Ejector spring	1c/	1c/			1c/	1c/		1		1c/	1			
Extractor								1						
Extractor spring														
Firing pin														
Disconnect														
Other														
Total unserviceable parts	1	1	0	0	1	1	0	2	0	1	1	0	0	0
Cyclic rate average	848	808		840	830	816	838	860	849	790	832	838	824	----
Propellant type	- - - IMR 4475 - - - - - - - - - - - - - - - - - -/ IMR CR8136 -													
Ammunition lot number	5031	5031	5031	5031	5031		5037 5031	5037	5037	5037	5044	5045	5045	5045
Rounds fired	6000	6000	2000	6000	6000	6000	6000	5431	6000	6000	6000	6000	6000	1004

Inclosure 6-2

2

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TABLE 54 — continued

Malfunction	Rifle Lot Number: 13XA	13XB	14X	15X	M15X	16Xp/	16XA	16XB	17X	18X	19X	20X	21X
Bolt fails to lock													
Bolt fails to hold	2d/			1					1			1	
Fails to eject	1	3	2				2			1		1m/	
Fails to feed - CV		2d/ 2g/		5d/		5	1	1	2d/	5g/	1	1	
Fails to feed - CNV				2d/		3		1	2d/				
Fails to fire semiauto				1h/									
Light blow													
Fails to assist													
Other	2j/	1i/ 1k/									1g/	1g/	
Total malfunctions	1	4	2	1	0	8	3	2	1	4	1	2	0
Unserviceable partsa/													
Hammer spring													
Ejector spring												1m/	
Extractor		1k/										1	
Extractor spring		1									1g/		
Firing pin													
Disconnect													
Other													
Total unserviceable parts	0	2	0	0	0	0	0	0	0	0	1	2	0
Cyclic rate average	795	740	755	827	---	729	767	870	818	759	794	830	839
Propellant type	(IMR CR8136 FOR ALL TESTS ON THIS PAGE)												
Ammunition lot number	5045	5045	5045	5053	5053	5053	5045	5045	5045	5045	5045	5061	5061
Rounds fired	6000	6000	6000	6000	1920	4444	6000	6000	6000	6000	6000	6000	6000

Inclosure 6-2

3

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TABLE 54 — continued

Malfunction	Rifle Lot Number 22X	23X	24X	25X	26X	27X	28X	29X	30X	31X	32X	33X	34X	35
Bolt fails to lock														
Bolt fails to hold														
Fails to eject			$3^{g/}$	$1^{d/}$				$1^{n/}$	1		1	$2^{m/}$		
Fails to feed - CV		$2^{g/}$		$2^{d/}$	1	2		$2^{d/}$			2			
Fails to feed - CNV			2											
Fails to fire semiauto				1										
Light blow											1			1
Fails to assist														
Other	$4^{g/}$						1							
Total malfunctions	0	0	4	2	1	2	1	0	1	0	4	1	0	1
Unserviceable parts														
Hammer spring														
Ejector spring			1	1			1					1		
Extractor														
Extractor spring	2	$1^{m/}$				1	1	1	1	1	1	1	1	
Firing pin														
Disconnect														
Other														
Total unserviceable parts	2	1	1	1	0	1	2	1	1	1	1	2	1	0
Cyclic rate average	840	750	813	797	788	800	771	847	822	815	827	829	824	825
Propellant type	(IMR CR8136 FOR ALL TESTS ON THIS PAGE)													
Ammunition lot number	5061	5070 5054	5054	5054	5054	5054	5054	5054	5054	5054	5054	5054	5054	5054
Rounds fired	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000

4

Inclosure 6-2

TABLE 54 — continued

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Malfunction	Rifle Lot Number													
	36	37	38X	39X	40X	41X[b]/	41A[b]/	41B[b]/	41C	41D	42X	43X	44X	45X
Bolt fails to lock	1						3							
Bolt fails to hold			1						1		1			
Fails to eject		1			1					4[m]/	1[m]/	1[m]/	1	
Fails to feed - CV	2		3	2	3		5	2				2		
Fails to feed - CVN			2											
Fails to fire semiauto														
Light blow														
Fails to assist														
Other						2						2[m]/		2[m]/
Total malfunctions	3	1	6	2	4	2	8	2	1	1	1	2	1	0
Unserviceable parts														
Hammer spring														
Ejector spring														
Extractor														
Extractor spring	1	1	1	1	1[e]/					2	1	2		2
Firing pin														
Disconnect														
Other														
Total unserviceable parts	1	1	1	1	1	0	0	0	0	2	1	2	0	2
Cyclic rate average	846	821	855	790	807	---	----	---	817	781	779	819	745	744
Propellant type	(IMR CR8136 FOR ALL TESTS ON THIS PAGE)													
Ammunition log number	5054	"054	5054	5054	5054	5054	5054	5054	5054	5054	5054	5054	5054	5054
Rounds fired	6000	6000	6000	6000	6000	382	1802	2000	6000	6000	6000	6000	6000	6000

Inclosure `-2

5

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TABLE 54 — continued

Malfunction	Rifle Lot Number 46	47	48X	49X	50	51
Bolt fails to lock						
Bolt fails to hold			1			
Fails to eject	2m/	2	1m/			
Fails to feed - CV	2	2				
Fails to feed - CHV						
Fails to fire semiauto						
Light blow						
Fails to assist						
Other	1m/	1m/			1	1
Total malfunctions	2	4	1	0	1	1
Unserviceable parts						
Hammer spring						
Ejector spring	1					
Extractor						
Extractor spring	1	2	1		1	1
Firing pin						
Disconnect						
Other						
Total unserviceable parts	2	2	1	0	1	1
Cyclic rate average	736	764	740	736	743	743
Propellant type	(IMR CR8136 FOR ALL TESTS ON THIS PAGE)					
Ammunition lot number	5060	5054	5054	5054	5054	5054
Rounds fired	6000	6000	6000	6000	6000	6000

Inclosure 6-2

6

TABLE 54 — continued (Footnotes)

a. No unserviceable parts allowed in the first 3,000 rounds.

b. Foreign material from defective round (blown primer) caused failure to lock - not charged against rifle.

c. Broken part (ejector spring) - not charged against rifle.

d. Bad magazine - not charged against rifle.

e. Gas tube plugged with carbon. Had not been cleaned for over 5,000 rounds (normally cleaned every 1,000 rounds - not charged against rifle.

f. Gas tube plugged with carbon. Had not been cleaned for over 3,000 rounds (normally cleaned every 1,000 rounds - not charged against rifle.

g. Gas tube obstructed by cleaning material (weapon had just been cleaned) - not charged against rifle.

h. Defective ammunition (no propellant).

i. Defective ammunition (defective primers).

j. Failure to extract - charged against rifle.

k. Broken part (extractor) - not charged against rifle.

m. Broken part (extractor or ejector spring) - not charged against rifle.

n. Broken part (extractor spring) - not charged against rifle.

o. Waiver granted to replace extractor spring prior to 3,000 rounds (#DSA-508 (W)-114).

p. Lot rejected.

q. Defective magazine or broken part - one or more, not charged against rifle.

Inclosure 6-2

7

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TABLE 55 -- MALFUNCTIONS AND UNSERVICEABLE PARTS, COLT'S 6000-ROUND ENDURANCE TESTS (16 May 1966 - To Present)
CONTRACT NUMBER DAAF03-66-C-0018

Malfunction	Allowed	Rifle Lot Number															
		1	2	3	4	5	6	7	8 i/	8A	8B	9	10	11	12	13	14
Bolt fails to lock	3																
Bolt fails to hold	3														2		
Fails to eject	4				1												
Fails to feed-CV a/	4	2		4		1	1	3	1	1						1	5
Fails to feed-CHV b/	3		1 e/				1			1						3	2
Fails to fire semiauto c/	3				1 f/										1		
Light blow	1						2		2	1					6 i/		3
Bolt assist fails	0																
Other	1						1		2 g/	1 h/			1		1		
Total malfunctions	11	2	0	4	1	1	5	3	5	3	0	0	1	0	7	4	10
Unserviceable parts d/																	
Hammer spring	1														1		
Ejector spring	1																
Extractor	1																
Extractor spring	2		1		1					1							
Firing pin	1																
Disconnect	1																
Other	1																1
Total unserviceable parts	3	0	1	0	1	0	0	1	0	1	0	0	0	0	1	0	1
Cyclic rate average		810	764	731	746	718	758	697	-	775	768	774	812	780	772	757	728
Propellant		(IMR CR8136 FOR ALL TESTS ON THIS PAGE)															
Ammunition lot number		5054	5054	5054	5054	5054	5054	5059	5059	5059	5059	5059	5059	5059	5059	5059	5059
Rounds fired		6,000	6,000	6,000	6,000	6,000	6,000	6,000	1,143	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000

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TABLE 55 — continued

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Malfunction	Rifle Lot Number 15	16	17	18	19	20	21	22[c]	23[c]	24[c]	25[c]	26[c]	27[n]	27A	27B
Bolt fails to lock															
Bolt fails to hold															
Fails to eject	3[j]	1	2		1										
Fails to feed - CV	4[k]													1	1
Fails to feed - CNV				1	1						1	1	5[l]	2	2
Fails to fire semiauto			2						2					1	
Light blow												1			
Fails to assist															
Other			2									1			
Total malfunctions	4	1	6	1	2	0	0	0	2	0	1	3	5	4	3
Unserviceable parts															
Hammer spring															
Ejector spring															
Extractor															
Extractor spring	1	1													
Firing pin															
Disconnect															
Other	1		1												
Total unserviceable parts	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Cyclic rate average	784	794	795	766	762	754	739	719	820	733	764	773	--	770	796
Propellant	(LCSP385 IS IMR 8208M - ALL OTHER LOTS ON THIS PAGE ARE WC846 (BALL))														
Ammunition lot number	5243	5244	5244 5251	5251 5244	5251	5255	5255	5255	5255	5256	5258	5258	LCSP385 5259	5259	5259
Rounds fired	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	523	6000	6000

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TABLE 55 — continued

Malfunction	28	29	30	31[t/]	32[t/]	33[t/]	34	35[t/]	36[n/]	36A[t/]	36B[t/]	37[t/]	38[t/]	39[t/]	40[t/]
Bolt fails to lock	1	1						1							
Bolt fails to hold															
Fails to eject	1	2				1		2	5					2	2
Fails to feed -CV			2	2	1	2		2		1	1				
Fails to feed - CNV															1[e/]
Fails to fire semiauto															
Light blow									1						
Fails to assist															
Other								1[m/]							
Total malfunctions	2	3	2	2	1	3	0	5	6	1	1	0	0	2	2
Unserviceable parts															
Hammer spring															
Ejector spring		1													1
Extractor															
Extractor spring	1							1							
Firing pin															
Disconnect															
Other															
Total unserviceable parts	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1
Cyclic rate average	797	786	823	822	805	806	771	855[n/]	--	768	773	787	785	767	777
Propellant	(LCSP385 IS IMR 8208M - ALL OTHER LOTS ON THIS PAGE ARE WC 846 (BALL))														
Ammunition lot number	LCSP385	LCSP385 5259	5265	5266	5266	5266 5244	5287	5286	5286 5298 LCSP385	5298	5298	5286	5286	5286	5308
Rounds fired	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	2,097	6,000	6,000	6,000	6,000	6,000	6,000

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TABLE 55 — continued

Malfunction	Rifle Lot Number													
	41	42c/	43a/	43A	43B	44	45c/	46c/	47c/	48c/	49c/	50c/	51c/	52c/
Bolt fails to lock													1	
Bolt fails to hold														
Fails to eject		3	5p/	1	2	1			1			1		
Fails to feed -CV		1		4	3q/	5r/		1						
Fails to feed -CVN				2	3									
Fails to fire semiauto		1o/	1											
Light blow		1												
Fails to assist														
Other														
Total malfunctions	0	5	6	7	6	3	0	1	1	0	0	1	1	0
Unserviceable parts														
Hammer spring														
Ejector spring														
Extractor														
Extractor spring														
Firing pin														
Disconnect														
Other					1	1								
Total unserviceable parts	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Cyclic rate average	762	808	--	747	788	743	769	815	794	757	775	726	761	754
Propellant	(TW18179 IS IMR 8208M - ALL OTHER LOTS ON THIS PAGE ARE WC846 (BALL))													
Ammunition lot number	TW18179	5244	5317	5317 5244	5317 5244	5244	5244	5244	5244	5274	5274	5278	5278	5278
Rounds fired	6,000	6,000	1,216	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000

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Table 55 — Cont'd (Footnotes)

[a] Failed to feed, cartridge visible.

[b] Failed to feed, cartridge not visible.

[c] Failed to fire, semiautomatic. (Fires two rounds, with a single trigger pull.)

[d] No unserviceable parts are allowed in the first 3,000 rounds.

[e] Failed to feed on account of damaged round.

[f] Defective primer.

[g] Fails to extract. Test suspended at 1,143 rounds.

[h] Fails to extract, because of broken extractor spring at 4,663 rounds.

[i] Three of these malfunctions not counted against the rifle due to the replacement of an unserviceable part (hammer spring).

[j] One of these malfunctions not counted against the rifle due to the replacement of an unserviceable part (extractor spring).

[k] Two of these malfunctions not counted against the rifle due to a defective magazine.

[l] Test suspended at 523 rounds. Malfunctions occurred with five different magazines.

[m] Failed to extract, due to broken extractor spring at 5,612 rounds.

[n] The lot of rifles was accepted on waiver because of calibration difficulties with the cyclic rate measurement device and after additional data was taken to establish that the average cyclic rate was less than 850, as required. The rate shown here is the average of data as recorded at the specific intervals.

[o] Failed to fire due to faulty ammunition (no weep hole).

[p] Test suspended at 1,216 rounds.

[q] Two of these malfunctions were attributed to one magazine, and were not counted against the rifle. Ammunition lot 5317 was reported as being very dirty. The rifle was cleaned at 3384 and 4402 rounds, and at 4402 rounds the change was made to ammunition lot 5244. (Both of these lots contained ball propellant.)

[r] Three of these malfunctions were attributed to one magazine and were not counted against the rifle.

[s] Lot rejected.

[t] Indicates test weapons that were not cleaned during the 6,000-round test. Although cleaning each 1,000 rounds was permitted, the test rifle was lubricated but not cleaned after each 1,000 rounds - and still passed the 6,000-round endurance test.

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TABLE 56 — IDENTIFICATION OF PROPELLANT TYPES USED IN COLT'S M16 QUALITY ASSURANCE TESTS

Ammunition Lot Number	Propellant	Ammunition Lot Number	Propellant
RA 5027	IMR 4475	RA 5243	WC 846
RA 5031	IMR 4475	RA 5244	WC 846
RA 5037	(IMR)CR 8136	RA 5251	WC 846
RA 5044	(IMR)CR 8136	RA 5255	WC 846
RA 5045	(IMR)CR 8136	RA 5258	WC 846
RA 5053	(IMR)CR 8136	RA 5259	WC 846
RA 5054	(IMR)CR 8136	RA 5265	WC 846
RA 5056	(IMR)CR 8136	RA 5266	WC 846
RA 5058	(IMR)CR 8136	RA 5274	WC 846
RA 5059	(IMR)CR 8136	RA 5278	WC 846
RA 5060	(IMR)CR 8136	RA 5286	WC 846
RA 5061	(IMR)CR 8136	RA 5287	WC 846
RA 5069	(IMR)CR 8136	RA 5298	WC 846
RA 5070	(IMR)CR 8136	RA 5305	WC 846
RA 5118	WC 846	RA 5307	WC 846
RA 5119	WC 846	RA 5317	WC 846
RA 5135	WC 846	RA 5318	WC 846
RA 5147	WC 846	RA 5325	WC 846
RA 5163	WC 846	RA 5326	WC 846
RA 5175	WC 846		
RA 5176	WC 846	WCC 6000	IMR 4475
RA 5222	WC 846	WCC 6051	WC 846
RA 5223	WC 846		
RA 5230	WC 846	LCSP 385	IMR 8208M
RA 5232	WC 846		
RA 5242	WC 846	TW 18179	IMR 8208M

Inclosure 6-2

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